MEMORANDUM

TO: US DOE/Savannah River Site Project File
EPA ID # SC1 890 008 989
Central File Room # 999 999

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DATE: September 30, 2005[1]

RE: Evaluation of the status of the **United States Department of Energy (US DOE) Savannah River Site (SRS)** under the RCRAInfo Corrective Action Environmental Indicator Event Codes (CA725 and CA750)
EPA I.D. Number: **SC1 890 008 989**

I. PURPOSE OF MEMO:

This memo is written to formalize an evaluation of SRS's status in relation to the following corrective action event codes defined in the Resource Conservation and Recovery Information System (RCRAInfo):

[1] The Environmental Indicator evaluation for the Groundwater Releases Controlled Determination (CA750) was completed on October 20, 1998.

1) Human Exposures Controlled Determination (CA725), and
2) Groundwater Releases Controlled Determination (CA750).

The application of these event codes at SRS adheres to the event code definitions found in the Data Element Dictionary for RCRAInfo.

Concurrence by the Operations Engineering Section Manager and the Division of Waste Management Director is required prior to entering these event codes into RCRAInfo. Your concurrence with the subsequent recommendations is satisfied by dating and signing above.

II. HUMAN EXPOSURES CONTROLLED DETERMINATION (CA725):

There are five (5) national status codes under CA725. These status codes are:

1)	YE	Yes, applicable as of this date.
2)	NA	Previous determination no longer applicable as of this date.
3)	NC	No control measures necessary.
4)	NO	Facility does not meet definition.
5)	IN	More information needed.

The first three (3) status codes listed above were defined in the January 1995 Data Element Dictionary for RCRIS. The last two (2) status codes were defined in the June 1997 Data Element Dictionary.

Note that CA725 is designed to measure human exposures over the entire facility (i.e., the code does not track SWMU specific actions or success). Every area at the facility must meet the definition before a YE or NC status code can be entered for CA725. The NO status code should be entered if there are current unacceptable risks to humans due to releases of hazardous wastes or hazardous constituents from any SWMU(s) or AOC(s). The IN status code is designed to cover those cases where insufficient information is available to make an informed decision on whether or not human exposures are controlled. If an evaluation determines that there are both unacceptable and uncontrolled current risks to humans at the facility (NO) along with insufficient information on contamination or exposures at the facility (IN), then the priority for the EI recommendation is the NO status code.

In Region 4's opinion, the previous relevance of NA as a meaningful status code is eliminated by the June 1997 Data Element Dictionary's inclusion of NO and IN to the existing YE and NC status codes. In other words, YE, NC, NO, and IN cover all of the scenarios possible in an evaluation or reevaluation of a facility for CA725. Therefore, it is Region 4's opinion that only YE, NC, NO, and IN should be utilized to categorize a facility for CA725. No facility in Region 4 should carry a NA status code.

This particular CA725 evaluation is the first evaluation performed for SRS. Because assumptions have to be made as to whether or not human exposures to current media contamination are plausible and, if plausible, whether or not controls are in place to address these plausible exposures, this memo first examines each environmental media (i.e., soil, groundwater, surface water, air) at the entire facility including any offsite contamination emanating from the facility rather than from individual areas or releases. After this independent media by media examination is presented, a final recommendation is offered as to the proper CA725 status code for SRS.

The following discussions, interpretations, and conclusions on contamination and exposures at the facility are based on the following reference documents:

1) 1992 RCRA Part B Permit Renewal Application, Vols. II-VII, XIV, and XXIII

2) 1988 RCRA Part B Permit Application, Vol. X

3) Hazardous and Mixed Waste Permit for SRS, issued September 5, 1995

4) Memorandums from Bureau of Land and Waste Management's RCRA and FFA Engineers and Hydrogeologists assigned to SRS, dated July 1998

5) SRS Environmental Report for 1997, WSRC-TR-97-00322

6) SRS Environmental Report for 1997 Summary, WSRC-TR-97-00323

7) SRS Environmental Data for 1997, WSRC-TR-97-000324

8) H-Area Hazardous Waste Management Facility Corrective Action Report - Third and Fourth Quarter 1997, dated March 1998

9) F-Area Hazardous Waste Management Facility Corrective Action Report - Third and Fourth Quarter 1997, dated March 1998

10) RFI/RI Work Plan for the F and H Areas Inactive Process Sewer Lines, dated March 1992

11) Mixed Waste Management Facility Groundwater Monitoring Report - Fourth Quarter 1997 and 1997 Summary, dated March 1998

12) Work Plan RFI/RI Report for Old Radioactive Waste Burial Ground (ORWBG), Vols. I and II, Rev. 0, dated November 1997

13) Burial Ground Complex Field Investigation Preliminary Data Report #1, dated January 1995

14) Burial Ground Complex Field Investigation Preliminary Data Report #2, dated January 1996

15) Lower Savannah District's Environmental Surveillance and Oversight Program's (ESOP) analytical results of surface water tritium sampling (electronic format)

16) Risk-Based Activity Calculations for Radionuclides, Engineering Calculation Number K-CLC-G-00023 (DOE, July 1997)

17) DOE/SRS-SCDHEC Memorandum of Agreement, dated April 8, 1985 and Amendment, dated May 5, 1988

18) Settlement Agreement 87-27-SW, dated May 1, 1987 and Amendment, dated June 14, 1989

19) Fish Advisory for Mercury, dated January 24, 1995 and Amendment for Cesium-137 and Strontium-90, dated May 14, 1996

20) SRS Environmental Report for 1996, WSRC-TR-97-0171

21) SRS Environmental Data for 1996, WSRC-TR-97-0077

22) Risk-Based Preliminary Remediation Goals for Radionuclides: Scoping Phase Calculations, WSRC-TR-94-0181, Revision 1

23) Agenda for Environmental Indicator Issues Conference Call & Attachment - *Introduction to Indoor Air Issues-10 Points in 10 Minutes* by Henry Schuver, EPA-HQ

24) SCDHEC ESOP 1997 Radiological Surface Water and Sediment Surveillance Project Report, 97RW002, December 1998

25) E-mail from SCDHEC's SRS/MWMF Project Engineer regarding Tritium at the Seepline

26) Preliminary Remediation Goals (PRG) Calculations for Cesium-137 in Surface Soils, Don Siron, October 1999

27) Health Consultation Creek Plantation / Savannah River Swamp, Tracy Shelley, December 6, 1999

28) Federal Guidance Report No. 12 - External Exposure to Radionuclides in Air, Water, and Soil, EPA-402-R-93-081, September 1993, pages 147, 155, 196, and 223

29) Solid Waste Management Units (SMWU's) Description of Access Restrictions (Odum to Sherritt, 8-1-00)

30) GPRA Environmental Indicators (EI) – Indoor Air Quality, ESH-FSS-2000-00206, Odum to Sherritt, 9-29-00)

31) E-mail from Maloney to Rippy, dated 4-5-2002: Draft sign e-mail to SCDHEC

32) Government Performance Results Act (GPRA) Status of Posting Signs (Hughes to Sherritt, 5-28-02)

33) The Risk Associated with Cesium-137 in Deer, WSRC-RP-2003-4027, S. A. Dyer & G. R. Wein, Revision 0, dated 2-19-03

34) Meeting notes from June 9, 2003 meeting with SRS regarding GPRA EI for the SRS - Vapor Intrusion into Buildings

35) Government Performance Results Act Environmental Indicators for the Savannah River Site – Vapor Intrusion into Buildings, CBU-SGW-2003-00930, (Cauthen to Sherritt, received 8-6-03)

36) E-mails from Rippy to Gaughan, dated 8-8-05 and 8-10-05: Vapor Intrusions Evaluation - Questions

37) Vapor Intrusions Evaluation: SRS Responses to SCDHEC Questions, dated 9-1-2005, received 9-6-2005

38) E-mail from Maloney to Rippy, dated 9-27-05: Fw: Creek Plantation Signs

39) Hazardous and Mixed Waste Permit for SRS, issued September 30, 2003

III. FACILITY SUMMARY:

The SRS occupies approximately 300 square miles within Aiken, Barnwell, and Allendale Counties in South Carolina and is bordered along the southwest property boundary by the Savannah River. The site is owned by the United States Department of Energy (DOE) and has been managed by the Westinghouse Savannah River Company (WSRC) since April of 1989. The original mission of the site was to produce nuclear materials including tritium and plutonium-239 (Pu-239) for national defense.

SRS currently employs approximately 16,000 people. The average population density around the site is 560 people per square mile.

Wastes generated at the site include solid, hazardous, radioactive (high- and low-level), and mixed. Past and present waste management practices include units such as an incinerator, seepage basins, pits, piles, containers, tanks, and landfills. Waste management units at the site which are completely or partially under RCRA authority include permitted units, interim status units, and solid waste management units (SWMUs).

PERMITTED UNITS

The units currently permitted at SRS include six post-closure units and three operating units. The permitted units under post-closure care are the M-Area Hazardous Waste Management Facility (HWMF), F-Area HWMF, H-Area HWMF, Metallurgical Laboratory HWMF, the Mixed Waste Management Facility, and the Sanitary Landfill. The permitted operating units are the Hazardous Waste Storage Facility, Consolidated Incineration Facility, and the Mixed Waste Storage Buildings (643-29E & 643-43E). A brief description of each unit follows.

M-Area Hazardous Waste Management Facility

The M-Area HWMF consists of a closed surface impoundment, process sewer line, overflow ditch, seep area, and a Carolina Bay (Lost Lake). The former surface impoundment was constructed in 1958 and operated at a working capacity of 7,920,000 gallons. Wastewater flow to the basin was terminated in July 1985, in accordance with RCRA requirements. Between 1958 and 1985, the M-Area HWMF received wastewater containing uranium (U) and solvents and degreasers used in fuel fabrication operations. Wastes received in the M-Area HWMF included F001 (spent halogenated solvents), D007 (chromium), D008 (lead), and D009 (mercury). The M-Area HWMF was closed in accordance with the approved closure plan by April 26, 1991.

F-Area Hazardous Waste Management Facility

The F-Area HWMF consists of three closed surface impoundments and an influent process sewer line. The former basins were constructed in 1955 and operated at a total working capacity of 20.5 million gallons. Between 1955 and 1988, the F-Area Seepage Basins received wastewater containing low-level radioactivity and chemicals from the F-Area Separations facilities. The wastes placed into the F-Area Seepage Basins were characterized as D002 (corrosive), D007 (chromium), and D009 (mercury). Wastewater flow to the basins was terminated on November 7, 1988 in accordance with RCRA requirements.

H-Area Hazardous Waste Management Facility

The H-Area HWMF consists of three closed surface impoundments and an influent process sewer line. The former basins were constructed in 1955. One of the basins was replaced in 1962. The total working capacity of the basins was 26.51 million gallons. Between 1955 and 1988, the H-Area Seepage Basins received wastewater containing low-level radioactivity and chemicals from the H-Area Separations Facilities. The wastes placed into the H-Area Seepage Basins were characterized as D002 (corrosive), D007 (chromium), and D009 (mercury). Wastewater flow to the basins was terminated on November 7, 1988 in accordance with RCRA requirements. The H-Area Seepage Basins were closed in accordance with an approved closure plan by July of 1991. The H-Area influent process sewer line (HIPSL) is currently undergoing closure.

Metallurgical Laboratory Hazardous Waste Management Facility

The Metallurgical Laboratory (Met Lab) HWMF consists of one closed surface impoundment, an influent process sewer line, a drainage outfall, and an adjacent Carolina Bay. The Met Lab basin was constructed in 1956 and operated at a total capacity of 145,000 gallons. Wastewater flow to the basin was terminated on November 8, 1985, in accordance with RCRA requirements. Between 1956 and 1985, the Met Lab HWMF received wastewater containing solvents and degreasers from the Savannah River Technology Center (SRTC) Equipment Engineering Section Metallurgical Laboratory. The wastes received in the Met Lab HWMF included F001 (spent halogenated solvents), F003 (spent non-halogenated solvents), F007 (spent cyanide plating bath solution), and D011 (silver) wastes. The surface impoundment was closed in accordance with the approved closure plan by 1992. The Carolina Bay has been closed as per RCRA. A risk assessment performed on the Carolina Bay has determined that it requires no further action.

Hazardous Waste Storage Facility

The Hazardous Waste Storage Facility (HWSF) consists of four buildings and three Solid Waste Storage Pads (SWSPs). Buildings 710-B, 645-N, 645-2N, and 645-4N are permitted to store hazardous and mixed waste in containers. The SWSPs may store only solid-form hazardous/mixed waste in containers. Building 710-B is an enclosed building with a four foot elevated concrete floor subdivided into three bays. 710-B may store up to 171,005 gallons of solid-form waste. Building 645-N is a partially enclosed metal building with a slab on-grade concrete floor subdivided into seven cells and has a permitted capacity of up to 157,540 gallons of waste. Building 645-2N is an enclosed metal building with a concrete slab floor subdivided into four cells. An additional area within 645-2N is used for waste re-packaging. Building 645-2N may store up to 284,111 gallons of waste. Building 645-4N is an enclosed metal building with a concrete slab floor and has a capacity of up to 339,317 gallons. The SWSPs consists of three paved asphalt areas near Buildings 645-N, 645-2N, and 645-4N. The SWSPs may store up to 737,879 gallons of waste in solid form. Additionally, SRS may conduct up to 12,717 gallons/day of treatment (buildings only) such as compaction, cutting, segregation/recontainerization, absorption, pH adjustment, and filtration.

Consolidated Incineration Facility

The Consolidated Incineration Facility (CIF) consists of container storage areas, tank storage areas, and an incineration system. The CIF is permitted to store up to 17,300 gallons of hazardous and mixed waste in containers and up to 33,400 gallons of hazardous and mixed waste in tanks. The incineration system may treat up to 1.213 tons per hour of hazardous and mixed waste. The incineration system consists of a waste feed system, an auxiliary fuel feed system, an incinerator with primary and secondary combustion chambers, an air pollution control system, an ash and blowdown solidification system, an automatic waste feed cut-off system, and a process control system with safety interlocks. Currently operations at this unit are suspended.

Mixed Waste Management Facility

The Mixed Waste Management Facility (MWMF) is comprised of 58 acres of landfill units within the greater Burial Ground Complex (BGC). These units consist of unlined trenches without leachate collection systems which received untreated hazardous, radioactive, and mixed wastes from 1972 until 1986. Some of the waste received was uncontainerized. The wastes received in the MWMF included metals, spent and ignitable solvents, and radionuclides. The MWMF was closed in accordance with the approved closure plan in 1990 and verified closed in April 1991. The Solvent Rags Portions of the Low Level Radioactive Waste Disposal Facility (LLRWDF), which is adjacent to the MWMF, includes trench areas similar to the MWMF trenches, engineered low level trenches (ELLT), and greater confinement disposal (GCD) areas. This area began receiving waste in 1986 and is currently undergoing final closure. Most of the waste are contained except for some miscellaneous bulky equipment. A total of 4,268,326 cubic feet of hazardous waste and 34,404 cubic feet of non-hazardous waste are buried in the Solvent Rags Portions. The wastes include F-listed solvent rags, radioactively contaminated process waste and soil, Class B and C wastes (as defined by the Nuclear Regulatory Commission (NRC)) and other high-activity waste forms.

Sanitary Landfill

The Sanitary Landfill Hazardous Waste Management Facility consists of two areas; the 32.6 acre Main Section which received waste from 1974 to 1987; and the 22.2 acre Southern Expansion, which received wastes from 1987 to 1994. Both areas of the Sanitary Landfill received solid wastes generated from SRS office, cafeteria, and industrial activities. The Main Section and the Southern Expansion of the Sanitary Landfill were identified as hazardous waste management units (Settlement Agreement #91-51-SW) on August 26, 1991 because solvent rags may have been disposed in both areas. The Main Section and Southern Expansion of the Sanitary Landfill were certified closed October 26, 1997 in accordance with the South Carolina Hazardous Waste Management Regulations, R.61-79.265, Subpart G.

Mixed Waste Storage Buildings (643-29E, 643-43E)

The Mixed Waste Storage Buildings (MWSBs) are located within the Solid Waste Management Facility (SWMF) and consist of two buildings, Building 643-29E and Building 643-43E. Buildings 643-29E and 643-43E may be used to store and/or treat mixed, non-hazardous radioactive, polychlorinated biphenyls (PCBs), and non-hazardous wastes in containers. The MWSBs are pre-engineered buildings with sheet metal roofing and partial sheet metal siding. The floor of each building is a concrete pad equipped with a sump and surrounded by 4-inch high curbing capable of containing at least 10 percent of the allowable maximum volume of waste containing free liquids. Building 643-29E may store up to 78,091 gallons of waste (26,330 gallons of waste with free liquids) and Building 643-43E may store up to 280,051 gallons of waste (144,880 gallons of waste with free liquids). Both buildings are prohibited from storing reactive and ignitable waste and hazardous-only waste. This facility may conduct up to 5236 gallons/day of treatment such as absorption and pH adjustment.

INTERIM STATUS UNITS

Operating Interim Status Units at SRS include the M-Area Mixed Waste Storage Shed (Bldg. 316-M) (undergoing closure); TRU Waste Pads 1; TRU Waste Pads 2-19 and the Experimental TRU Waste Assay Facility/Waste Certification Facility (ETWAF/WCF) (undergoing closure); SRTC *(SRL)* Mixed Waste Storage Tanks, M-Area Waste Storage Pad (Bldg. 315-4M) (undergoing closure), and Liquid Waste Solvent Tanks S33-S36.

Post-closure units include the old Burial Ground Solvent Tanks (S23-S30) and the Mixed Waste Oil (Tritiated) Storage Tank (S-32).

SOLID WASTE MANAGEMENT UNITS

A list of the Solid Waste Management Units[2] at SRS (Appendix C of the US DOE/US EPA/ SCDHEC Federal Facility Agreement) is included as Attachment 1 to this document. A final remedy has been selected for forty (40) of these units.

Known SWMUs are posted with a sign which includes the unit's name and the name of a contact person with information on that unit. It is SRS's practice to identify the locations of known SWMUs by placing an orange marker ball at each corner of each unit. Areas with radiological contamination are roped off and placarded as appropriate.

IV. MEDIA BY MEDIA DISCUSSION OF CONTAMINATION AND THE STATUS OF PLAUSIBLE HUMAN EXPOSURES:

Contamination at SRS is described on a media-by-media basis below. Investigations of Operable Units (OU) and SWMUs include all potentially affected media.

SOILS

SRS has a program established to monitor radioactivity in soils on a yearly basis. In 1997, SRS collected four soil samples from areas onsite: E-Area (burial ground), F-Area, H-Area, and Z-Area. Additionally, two samples were taken off-site - one sample approximately 15 miles south southeast of the site (Hwy. 301 at state line) and one sample at Savannah, GA, approximately 100 miles from the site. Cesium-137 (Cs-137) (a manmade radionuclide) was detected at levels above the nominal lower limit of detection (LLD)[3] at two onsite locations (H-Area and F-Area), and one off-site

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2 These SWMUs fall under the authority of both RCRA and CERCLA as per the SRS Federal Facility Agreement between DOE, EPA, and SCDHEC.

3 The SRS Environmental Report for 1997 defines the lower limit of detection (LLD) as the smallest

location (Hwy. 301 at state line). The maximum onsite concentration was approximately 1.75E-01 pCi/g at H-Area for Cs-137. The off-site concentration was ~ 1.36E-01 pCi/g. Pu-238 was detected above the nominal LLD at F-Area at ~ 1.60E-02 pCi/g. Pu-239 was detected above the nominal LLD at F- and H-Areas with the maximum being ~ 1.31E-02 pCi/g at H-Area. Total strontium (Sr-89,90) was detected above the nominal LLD at the Highway 301 location at ~ 1.08E-01 pCi/g.

Note: Results of FFA (i.e. RCRA/CERCLA) investigations indicate that the results of the SRS soil surveillance program are not representative of the full range of radioactive contamination present in onsite soils. FFA investigations have identified areas of the site with higher concentrations than those mentioned above.

Activities detected in the off-site soils have been compared to residential soil risk-based activities (RBAs) calculated for radionuclides by the Department of Energy (Engineering Calculation Number K-CLC-G-00023 (DOE, July 1997)). These numbers are calculated at the 1E-6 risk level. At both off-site soil sampling locations, activities in soils for cobalt-60 (Co-60) exceeded DOE's RBA. Additionally, the activities for Cs-137 at both off-site locations exceeded the RBA for Cs-137 plus daughter products.

Off-site soil contamination at the above locations would most likely occur via deposition of contaminants from the atmosphere. Representatives of SRS have pointed out that the levels of soil contamination (from Cs-137) present at these locations are comparable to that resulting from fallout (from atmospheric nuclear testing). It should be noted, however, that SRS's radiological soil surveillance samples were not taken in the prevailing wind direction (of the site) as per the wind rose included in the SRS Environmental Report for 1997.

Off-site non-radiological soil data is not available. Characterization of soils for non-radioactive constituents at SRS typically occurs through RCRA/CERCLA-driven investigations. It should be noted that many areas of the site are currently under investigation or have yet to be investigated. A description of the known soil contamination resulting from RCRA-permitted units and RCRA/CERCLA SWMUs (with data available as of 1998) is included in the following tables.

SOILS - Permitted or Interim Status Units	
Unit	Description
M-Area HWMF	Waste closed in place. Soils contaminated -chromium, lead, mercury, halogenated solvents. Unit under post-closure care.
F-Area HWMF	Waste closed in place. Soils underlying basins contaminated with mercury, chromium, Sr-90. Under post-closure care.
H-Area HWMF	Waste closed in place. Soils underlying basins contaminated with lead,

concentration/amount of analyte that can be reliably detected in a sample at a 95 percent confidence interval.

SOILS - Permitted or Interim Status Units	
	mercury, silver, zinc, elevated sodium, radionuclides. Under post-closure care.
Met Lab HWMF	Waste closed in place. Vadose zone contaminated with TCE, PCE. Corrective action taken includes soil vapor extraction (SVE). Unit under post-closure care.
HWSF	Operating. No known soil contamination associated with this unit. Soil samples will be taken as part of closure activities.
CIF	Operations suspended. No known soil contamination associated with this unit. Soil samples will be taken as part of closure activities.
MWMF (including LLWRDF expansion)	Unit closed with waste in place including metals, solvents, and radioactive constituents. No soil data available.
Sanitary Landfill	Waste closed in place - inorganics, plastic, construction debris, acids, petroleum contaminated soils, solvent-contaminated rags. VOCs present in soils.
Mixed Waste Storage Buildings (643-29E, 643-43E)	Operating. No known soil contamination associated with this unit. Soil samples will be taken as part of closure activities.
Burial Ground Solvent Tanks (S23-S30)	Closed. Waste (except heel) transferred to the new Liquid Waste Solvent Tanks (S33-S36). Emptied tanks grouted. Tanks under post-closure care along with the MWMF.
Mixed Waste Oil (Tritiated) Storage Tank (S32)	Closed. Waste removed. Tank grouted. No known soil contamination associated with this tank. Any groundwater contamination (none known at this time) associated with this unit would be addressed under the MWMF post-closure plan.
F&H Seepage Basin Influent Sewer Lines	F-Area contaminants include silver, barium, beryllium, cadmium, cobalt, copper, manganese, mercury, nickel, antimony and vanadium. H-Area contaminants include mercury, silver, and vanadium.
Operating Interim Status Units	Soil data unavailable.

SOILS – SWMUs	
Unit	Description
A-Area Burning/ Rubble Pits & Rubble Pile	Benzo[a]pyrene and Aroclor 1260 above risk-based concentrations and soil screening levels. Contamination has resulted in a VOC groundwater plume.
A-Area Miscellaneous Rubble Pile	PCBs, metals, and semivolatiles present in soils above RBCs. Still undergoing characterization.
C-Area Burning/ Rubble Pit	Contamination above RBCs and soil-screening levels (SSLs). Contaminants include metals, radionuclides, volatiles, semivolatiles, dioxins, PCBs and TCE. RFI/RI BRA not yet approved. Contamination has resulted in a VOC groundwater plume (DNAPL present).
Central Shops Sludge Lagoon	Characterization not yet completed. RFI/RI Field Start scheduled 12/31/98.
C, F, & P Coal Pile Runoff Basin	Maximum contamination detected in soils at 0-1 ft interval. Affected soils were removed and areas backfilled with four feet of clean soil. Final remedy is no further action.
CMP Pits	Metals and VOCs present in soils. A portion of the unit known as the 'ballast area' is contaminated with PCBs.
C-Reactor Seepage Basins	Soils contaminated above RBCs and SSLs - metals, semi-volatiles, volatiles, and pesticides. Characterization not yet complete.
D-Area Oil Seepage Basin	Soils have been treated through interim actions. Final remedy consists of institutional controls for groundwater.
D-Area Ash Basin & D-Area Coal Pile Runoff Basin	Ash still present. Soils contaminated by radioactive constituents and metals. Characterization not yet complete. RFI/RI Work Plan under review.
F-Area Retention Basin	Contamination in soils above risk-based numbers and soil screening levels - primarily radioactive constituents. Proposed remedy is to grout contaminated soils in-place. Once remediated, unit will be maintained under institutional controls.
Old F-Area Seepage Basin	Contamination in soils above risk-based numbers. Contaminated soils will be grouted in place.
Ford Building Seepage Basin	Soils contain radioactive constituents and metals. Unit is still undergoing characterization.

SOILS – SWMUs	
Ford Building Waste Site	PCBs detected in building. No known soil contamination.
F- & H-Area Tank Farms	High-level waste tanks. Assessment of soils will be deferred until closure is complete for a geographical grouping of tank systems.
H-Area Retention Basin	Contaminated with radioactive constituents. Unit still undergoing characterization.
K-Area Bingham Pump Outage Pit	Contamination in soils above risk-based numbers. Cs-137 and Radium-226 present. Results of leachability model has indicated no threat to groundwater from soil contamination.
K-Area Burning/ Rubble Pit & Rubble Pile	Contamination present above risk-based numbers and soil screening levels. Constituents include benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene, indeno[1,2,3-c,d]pyrene, fluoranthene, pyrene, and lead.
K-Area Coal Pile Runoff Basin	Constituents of concern in soils include aluminum, iron, antimony, arsenic, and vanadium. Radium-226 and radium-228 detected in deeper soils. Coal fines were removed from basin and unit was backfilled. Institutional controls are in place. Groundwater monitoring is required as part of final remedy. If a second exceedence of MCLs occurs, SRS will be required to submit a corrective measures plan.
K-Area Reactor Seepage Basin	Soil contamination present. Radioactive constituents include Cs-137, Sr-90, Co-60, americium-241, and Pu-239/240.
L-Area Burning/ Rubble Pit & L-Area Gas Cylinder Disposal Facility & L-Area Rubble Pile	Mercury batteries found in bit during investigative trenching. Unit undergoing characterization. Gas cylinders removed. Unit undergoing characterization. Piles have been removed.
L-Area Oil/Chemical Basin & L-Area Acid/Caustic Basin	Radioactive constituents and metals present in soils. Contamination will be stabilized by grouting in-place.
L-Area Reactor Seepage Basin	Soils suspected to be contaminated primarily with radioactive constituents, however, investigation has not been completed.

SOILS – SWMUs	
L- & P-Area Bingham Pump Outage Pits	Soils contaminated above risk-based numbers for radiological constituents.
Miscellaneous Chemical Basin/Metals Burning Pits	Soils contaminated with metals and VOCs. Contamination has resulted in VOC groundwater plume.
Old Radioactive Waste Burial Ground (including Solvent Tanks 1-22)	Soils contaminated above RBCs/SSLs. Contaminants include radionuclides, metals, and volatiles. An engineered low-permeability soil cover has been installed to reduce rain infiltration. Unit contains "classified" wastes which have not yet been identified.
P-Area Reactor Seepage Basin	Soils suspected to be contaminated primarily with radioactive constituents, however, investigation has not been completed.
R-Area Bingham Pump Outage Pits	Characterization has not been completed for soils.
R-Area Reactor Seepage Basins & 108-4R Overflow Basin	Contamination present in soils - Cs-137 and Sr-90. Basins have been covered by asphalt to shield radiation and inhibit infiltration/migration of contaminants. No apparent exceedences of risk-based concentrations (RBCs). However RFI/RI BRA has not yet been approved.
SRL Seepage Basins	High concentrations of radioactive constituents. SRS has proposed removal and off-site disposal for a portion of contaminated soils and in-place stabilization for the remaining portion.
New TNX Seepage Basin, Old TNX Seepage Basin, Burying Ground, Upper Discharge Gully	Soil contamination in New Seepage Basin includes barium, manganese, mercury, nickel, radium-226, and uranium-238. Sediment contamination includes radium-226.
TNX Lower Discharge Gully, Outfall Delta, and Swamp	Characterization not yet completed.

SRS uses a combination of signs, fencing, security, and training to limit human exposure to known areas of onsite soil contamination. The Department has evaluated these administrative and physical

controls to ensure that SWMU boundaries are clearly identifiable to a visitor or onsite worker.

SEDIMENTS

The SRS surveillance program for non-radiological contaminants in sediments consists of the collection of eight (8) onsite samples (Upper Three Runs Creek (2 samples), Tinker Creek, 400-D, Four Mile Creek, Pen Branch, Steel Creek, and Lower Three Runs Creek) and three (3) offsite (Savannah River at River Mile 160, Vogtle Discharge, and River Mile 120). The samples are analyzed for herbicides/pesticides and metals. In 1997, no herbicides or pesticides were found in sediments above detection limits. However, for Toxaphene, 2,4-D, and Silvex the detection limits used were above the accepted practical quantitation limits for these constituents. Metals testing included analysis for aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, selenium, silver, uranium, and zinc. In general, the highest onsite metal concentrations were found at the Steel Creek and 400D sample locations. The highest offsite metal concentrations were found at the Savannah River Mile 120 location.[4]

The SRS surveillance program for radioactive constituents in sediments is more extensive. As part of their regular survey, seventeen (17) onsite samples and eleven (11) offsite samples (Savannah River) are collected. The highest onsite sediment radionuclide concentrations were found in Four Mile Creek. Constituents include Cs-137 and Co-60 (both manmade), Pu-238 and -239, and Sr-89 and -90. The highest activity reported was approximately 18.9 pCi/g for Cs-137. From the sediment samples taken in the Savannah River, the highest activity was detected in samples from the mouth of Lower Three Runs Creek for Cs-137 (~1.24 pCi/g) and the mouth of Upper Three Runs Creek for Pu-238 and -239.

Activities in onsite sediments have been compared with risk-based preliminary remediation goals (PRGs) for commercial industrial soils (WSRC-TR-94-0181)[5]. For Co-60, four of seventeen samples or 24% exceed a risk-based activity at the 1E-6 level. For Cs-137, 59% of the samples exceed - one sample at the 1E-4 level, seven (7) at the 1E-5 level, and two (2) at the 1E-6 level. One sample exceeded at the 1E-6 level for U-235.

The activities found in the offsite sediments (Savannah River) have been compared with residential soil risk-based activities (RBAs) calculated for radionuclides by the Department of Energy (K-CLC-G-00023). For Co-60, sediment activities exceeded the RBA at the Highway 301 sampling location and at the mouth of Lower Three Runs Creek. The RBA for Co-60 was exceeded at five (5) other

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4 Because the data presented in the SRS Environmental Data for 1997 is TCLP data (i.e. in units of mg/L) rather than 'totals' data (i.e. in units of mg/kg), a comparison to EPA Region III's residential soil risk-based concentrations (RBCs) could not be made.

5 Currently there are no available risk-based numbers for radionuclides in sediments. For comparison purposes, risk-based activities (RBAs) for soils were used. Because the routes of exposure from soils and sediments differ, any conclusions drawn from comparing sediment activities with soil RBAs would be uncertain.

sampling points, however, the SRS Environmental Data for 1997 reports these sampling locations as being below background. For Cs-137, sediment activities exceeded the RBA for Cs-137 (+ daughter products) at the mouths of Beaver Dam Creek, Lower Three Runs Creek, and Upper Three Runs Creek, the Highway 301 sampling location, and Demiere's Landing (control).

In 1997, SC DHEC's ESOP program also collected sediment samples from seven (7) onsite locations and five (5) off-site locations. Of these, seven (7) exceeded an RBA for Cs-137. Two onsite locations exceeded the industrial RBA at the 1E-6 level - Fourmile Branch (SV-2043) and Lower Three Runs (SV-2020). Five (5) offsite locations exceeded a residential RBA. Upper Three Runs Mouth (SV-2011), Steel Creek Mouth (SV-2017), Steel Creek Boat Landing (SV-2018), and Lower Three Runs Mouth (SV-2020) exceeded at the 1E-5 level. Highway 301 (SV-118) exceeded at the 1E-4 level.

Creek Plantation

In the 1960s, a portion of the Savannah River Swamp[6] was contaminated by radioactive constituents released as a result of SRS operations. Approximately 25 Ci of Cs-137 and 1 Ci of Co-60 were deposited into an area of the Savannah River Swamp between Steel Creek Landing and Little Hell Landing. The majority of the contaminated area is located offsite on private property known as Creek Plantation.[7] According to the Savannah River Site Environmental Report for 1996, this area has been surveyed regularly by SRS since 1974. A comprehensive survey, typically consisting of 54 sampling locations (divided among ten (10) sampling trails - all located offsite), is conducted approximately every five (5) years. In 1996, a comprehensive survey was conducted of the area which consisted of shallow soil samples (0-3 inches) and vegetation samples at each accessible sampling location and one 12-inch core sample (divided into 3-inch intervals for analysis) per sampling trail. The 12-inch core samples were taken at those locations on each trail that have historically had the highest activity levels. Each sample was analyzed for gamma-emitting radionuclides and Sr-89,90. The analytical data resulting from this survey is included in the Savannah River Site Environmental Data for 1996.

Cs-137 was detected in 80 of 81 soil samples and 40 of 46 vegetation samples. The highest soil concentration of Cs-137 detected was 98.8 pCi/g at sampling trail #8 (between Cannuck Lake and Little Hell Landing). The Creek Plantation Cs-137 soil data was evaluated from both a dose perspective and a risk perspective. The Department's Division of Health Hazard Evaluation

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6 For much of the year, portions of the affected area are not covered by water. Therefore, comparison of the activities in Creek Plantation to soil RBAs are appropriate. Indeed, the SRS Environmental Data for 1996 reports the Savannah River Swamp (Creek Plantation) Survey results as soil results.

7 Creek Plantation is a working farm that raises horses and cattle. There are permanent residences on the Creek Plantation property, however not in areas of known contamination. There have, however, been reports of an individual living on a boat in the affected areas of the swamp. Additionally, there may be a hunting lodge located in the affected area.

calculated the dose (from the ingestion pathway only) from the highest soil concentration detected, 98.8 pCi/g. The resulting dose due to ingestion from this concentration was 0.19 mrem/year (see Attachment 2). The dose from external exposure was estimated using dose coefficients obtained from Federal Guidance Report No. 12 - External Exposure to Radionuclides in Air, Water, & Soil. Using this approach, the effective dose due to external radiation would be about 283 mrem/year for the residential scenario. For the trespasser scenario, the dose would be approximately 55 mrem/yr (see Attachment 3[8]). An estimate of the total dose to the individual can be obtained from the sum of the doses from the ingestion and external pathways. The data was evaluated from a risk perspective by comparing the soil data to screening-level risk-based activities (RBAs) or preliminary remediation goals (PRGs) calculated by the Bureau of Land and Waste Management's Federal Facility Agreement Section (see Attachment 4). Seventy-eight (78) of the 81 soil samples (96%) taken exceeded the 1E-6 residential scenario PRG[9] for Cs-137 + daughters (D). Seventy (70) soil samples (86%) exceeded the 1E-6 industrial scenario PRG[10] for Cs-137 + D. Sixty-two (62) samples (77%) exceeded the 1E-6 trespasser scenario PRG[11] for Cs-137 + D. Additionally, 48%, 35%, and 20% of the soil samples exceeded the 1E-4 residential, industrial, and trespasser scenario PRGs for Cs-137 + D, respectively. The highest vegetation concentration was 63.8 pCi/g at sampling trail #7.

Co-60 was detected at 40 of 81 soil samples and 6 of the 46 vegetation samples. The highest observed Co-60 concentrations were approximately 0.4 pCi/g in soil and 0.3 pCi/g in vegetation at sampling trails #1 (just above Steel Creek Landing) and #2 (near Boggy Gut Lake), respectively. Twenty-three (23) of the soil samples (28%) exceeded the 1E-6 residential scenario RBA for Co-60. Twenty-one (21) or 26% exceeded the 1E-6 industrial scenario RBA.

Strontium was detected in 10 of 81 soil samples and 9 of 46 vegetation samples. The highest detected Sr-89,90 concentration in soil was 0.28 pCi/g at sampling trail #4 (near Jacks Lake) and the highest detected vegetation concentration was 1.61 pCi/g at sampling trail #1.

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8 The attachment only shows the calculation for the trespasser scenario. The annual effective dose for the residential scenario can be calculated by changing 't' in the equation to reflect the residential exposure duration, i.e. 350 days/yr, 24 hours/day.

9 Based on Siron's *Preliminary Remediation Goal (PRG) Calculations for Cesium-137 in Surface Soils*, dated October 1999. The $1X10^{-6}$ risk-based number for soil is 0.0199 pCi/g for the residential scenario. If the 1994 $1X10^{-6}$ residential soils RBA (from WSRC-TR-94-0181) is used the results are the same - 78 of 81 soils samples (96%) exceed the RBA.

10 Based on Siron's *Preliminary Remediation Goal (PRG) Calculations for Cesium-137 in Surface Soils*, dated October 1999. The $1X10^{-6}$ risk-based number for soil is 0.104 pCi/g for the industrial scenario.

11 Based on Siron's *Preliminary Remediation Goal (PRG) Calculations for Cesium-137 in Surface Soils*, dated October 1999. The $1X10^{-6}$ risk-based number for soil is 0.323 pCi/g for the trespasser scenario. This scenario takes into account both ingestion and dermal routes of exposure. It assumes incidental soil ingestion (100 mg/day) and external gamma exposure 18 hours/day for 90 days/year for 10 years.

Because the screening level risk estimate (resulting from Cs-137 contamination) from a likely scenario such as the trespasser scenario exceeds $1X10^{-6}$ at the majority of sampling locations and $1X10^{-4}$ at 20% of the sampling locations, human exposures in this area need to be controlled pending a more complete evaluation of risk.

GROUNDWATER

SRS is located on the Upper Coastal Plain of South Carolina. Underlying sediments consist of unconsolidated sands, clays, and limestone. These sediments are underlain by sandstones and older metamorphic and igneous rock. The sandy sediments contain several productive aquifers interspersed with clay layers. These aquifers discharge to the Savannah River and its associated swamps and tributaries.

Releases from solid waste management units (SWMUs) and/or areas of concern (AOCs) have contaminated groundwater at concentrations above relevant action levels such as EPA's Drinking Water Standards (i.e. Maximum Contaminant Levels (MCLs)). According to the *SRS Environmental Report for 1997*, groundwater beneath 5 to 10 percent of the site has been contaminated by industrial solvents, tritium, metals or other constituents used or generated by SRS operations.

The highest concentrations of known groundwater contamination are generally found in the F-Area Seepage Basins, H-Area Seepage Basins, and Mixed Waste Burial Complex. Groundwater contamination is also found in other areas of the facility. These areas include A-Area, C-Area, D-Area, K-Area, L-Area, M-Area, N-Area, P-Area, R-Area, Sanitary Landfill, TNX, and the General Separations Areas. Groundwater contamination in these areas consists mainly of chlorinated volatile organics, metals, radionuclides, and tritium.

A-Area and M-Area are located in the northwest portion of the site. M-Area was used for production of nuclear fuels, targets, and other reactor components. A-Area houses administrative and research facilities, including the Savannah River Technology Center. In the A- and M-Area, the water table slopes to the south and southeast toward Tims Branch and unnamed tributaries thereof. The water table also slopes towards low lying swamps adjacent to the Savannah River west of the A- and M-Areas. Most of the water in the upper saturated zone migrates downward toward lower water-bearing zones. Organic constituents are the primary contaminants in this area. The entire contaminant plume covers approximately 3 square miles and is approximately one third of a mile from the SRS property boundary. The concentration of trichlorethylene is approximately 41,000 ug/l in well cluster MSB-2C. This concentration is significantly elevated compared to the groundwater protection standard of 5 ug/l. Remedial efforts for groundwater in the A- and M-Areas, which include capping the basins and extracting and treating groundwater, have altered the groundwater and contaminant flow patterns in the water table aquifer and underlying Lost Lake Aquifer.

C-Area is located in the west-central portion of the facility. The C-reactor achieved criticality in March 1955 and was shut down in 1985. It was placed on cold standby in 1987. Groundwater flow

in this area is toward incised creeks in the area. Flow is generally west toward Four Mile Branch. Water from the disassembly basins, which contained tritium, was discharged to reactor seepage basins or surface streams. The burning/rubble pits and basins in this area are also sources of groundwater contamination. Trichloroethene is the most widespread contaminant in the area. Lead, tritium, and other radionuclides contribute to groundwater contamination in the C-Area.

D-Area is located in the southwest portion of the facility. A large coal-fired power plant and inactive heavy water facilities are located here. TNX is also located in this area. The nearest property boundary is approximately one quarter mile to the west. The water table in D-Area discharges to the Savannah River and nearby swamps along Beaver Dam Creek. There is substantial groundwater contamination near the coal pile runoff containment basin. The groundwater contamination consists of elevated metals, alpha-emitting radionuclides and volatile organics. A second groundwater contaminant plume is emanating from the oil disposal basin. This plume contains lead and volatile organics. The groundwater contaminant plume beneath TNX discharging to the Savannah River Swamp, consists primarily of volatile organics and nitrates. Interim measures have been initiated for remediation of contaminated groundwater in the TNX area.

The General Separations area is located in the central part of the facility. It includes E-Area, F-Area, H-Area, S-Area, and Z-Area. Reactor produced materials are processed in the chemical separations plants in F- and H-Areas. Uranium, Pu-238, and Pu-239 are separated from each other and from fission products. Purification and packaging of tritium and storage of fission wastes are also conducted in these areas. The Mixed Waste Management Facility (E-Area), F-Area, and H-Area are located on the groundwater divide between Four Mile Branch and Upper Three Runs Creek. S-Area and Z-Area are located on the groundwater divide between Upper Three Runs Creek and its tributaries to the west. The F-Area and H-Area seepage basins were used to dispose of liquids containing radionuclides, tritium, metals, organics, and nitrates. Radioactive waste has leached into groundwater beneath the H- and F-Area tank farms. Groundwater plumes from the F-Area and H-Areas are discharging radionuclides, metals, nitrates, and tritium into Four Mile Branch. Groundwater plumes from the Mixed Waste Management Facility are discharging volatile organics, radionuclides, and metals to Four Mile Branch. An extensive tritium plume is migrating north from the Solid Waste Disposal Facility toward Upper Three Runs Creek. Groundwater remediation systems have been installed for the F-Area and H-Area seepage basins. The systems include a series of extraction and injection wells. The contaminated groundwater is treated by a specially designed system that reduces all contaminants, except for tritium and nitrates, to concentrations below risk based levels. The extracted groundwater is then reinjected into the affected aquifers. The overall effectiveness of the groundwater remediation systems for the F- and H-Areas has not been determined as of this date. SRS has proposed remedial options for the groundwater plumes emanating from the Mixed Waste Management Facility. Those options are currently under review by the Department.

K-Area is located in the south-central portion of the facility and contains the K-reactor. The reactor achieved criticality in 1954 and was shut down in 1988. The reactor was placed on cold standby in

February 1996. K-Area is located between Pen Branch and Indian Grave Branch. Deeper groundwater flows toward the Savannah River. The largest plume in the area is located beneath the disassembly basin and is characterized by elevated concentrations of tritium and volatile organics. Groundwater beneath the ash basin and coal pile runoff area contains gross alpha. Groundwater beneath the burning/rubble pit is contaminated with tetrachloroethene.

The L-Area is located in the south-central part of the facility and contains the L-Area reactor. The L-Area reactor achieved criticality in 1954 and continued production through 1968. It then operated from 1985 until 1988. It was placed on standby in 1991. This area includes the chemicals, metals, and pesticides (CMP) pits which are located near the head of Pen Branch. The pits were used from 1971 through 1979 to dispose of drummed oil, organic solvents, pesticides, and metals containing wastes. Most of the contaminated material was removed in 1984 when the pits were excavated, backfilled and capped. A groundwater contaminant plume consisting mainly of TCE is migrating toward Pen Branch. Remedial alternatives are being evaluated for the CMP pits. A second plume is located beneath the reactor building. Increased tritium activity has been recorded in groundwater samples collected southwest of the reactor building. Groundwater beneath the disassembly basin and the oil and chemical basin is contaminated with tetracholorethene and nitrate.

N-Area (Central Shops) is located in the central portion of the facility. This area provides supply, maintenance and other support services, and includes a hydrofluoric spill area, diesel spill area, burning/rubble pits, Fire Department Training Facility and the Ford Building seepage basin. Four Mile Branch, Upper Three Runs Creek and several other incised creeks, located between N-Area and the SRS boundary, are areas of groundwater discharge. Groundwater beneath the Ford Building has been contaminated with metals. Groundwater has also been contaminated with organics due to spills in the area.

P-Area is located in the south-central portion of the facility and includes the P-reactor. The P-reactor achieved criticality in 1954 and was shutdown in 1987. Groundwater beneath the disassembly basin and reactor seepage basin has been contaminated by releases of tritium and lead. Trichloroethene and cadmium are constituents of concern in the groundwater near the burning/rubble pits and coal pile runoff basin.

R-Area is located in the east-central portion of the facility and includes the R-reactor. The reactor achieved criticality in 1953 and was permanently shutdown in 1964. R-Area is near a groundwater divide between Mill Creek and PAR Pond. Groundwater beneath the disassembly basin and seepage basin is contaminated with radionuclides and metals. In 1957, an experimental fuel element failed during a test and the seepage basin received approximately 2,700 Ci of gross beta activity along with Sr-90 and Cs-137. The basin was backfilled in 1957.

Sanitary Landfill and B-Area are located in the eastern portion of the facility. The Sanitary Landfill received office, cafeteria and industrial waste during 1974. Up until 1992, solvent laden rags and wipes used for cleaning, decontaminating and calibrating were disposed of in the landfill. Organic

compounds, tritium, metals and other radionuclides are found in groundwater beneath the landfill. An interim groundwater remediation system has been installed in the southern portion of the landfill. This system is targeting the treatment of the organic contaminants found in groundwater beneath the landfill.

SURFACE WATER

SRS is bordered on the southwestern property boundary by the Savannah River for approximately 35 river miles. The Savannah River is used as a source of drinking water for approximately 56,000 residents downriver from SRS. Five major streams from the SRS property feed into the Savannah River. These include Upper Three Runs Creek, Four Mile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek. All of the streams receive effluents from various onsite facility operations. According to the SRS Environmental Report for 1997, tritium accounts for most of the radioactivity discharged in SRS liquid effluents. The total amount of tritium released directly from process areas to site streams in 1997 is reported to be 1570 Ci. This is a 65% increase from 1996. The increase is attributed to increased operations at Effluent Treatment Facility (ETF) and D-Area. The SRS Environmental Report for 1997 also reports that the total quantity of tritium migrating from the seepage basins and Mixed Waste Management Facility / Burial Ground Complex (MWMF/BGC) was about 6,780 Ci. Therefore, approximately 81% of the tritium released to site streams is due to releases from seepage basins and MWMF/BGC. Tritium activity resulting from MWMF/BGC at the 'hottest' point along the seepline averages 41,400 pCi/L but has reached 75,522 pCi/L. Elsewhere, along the seepline (i.e. along Old F-Area Effluent Ditch) the maximum recorded activity was 1629 pCi/mL and activities have averaged 873 pCi/mL.

Two manmade bodies of water are located on SRS. These include PAR Pond and L-Lake. PAR Pond was constructed in 1958 to provide cooling water for P-Reactor and R-Reactor. PAR Pond is 2,640 acres and approximately 60 feet deep. The 1,000 acre L-Lake was constructed in 1985 to receive heated cooling water from L-Reactor.

SRS and SCDHEC conduct surface water sampling for radionuclides and inorganics along the Savannah River, streams and ponds on the SRS property. Continuous surveillance for radionuclides is conducted by SRS at Tims Branch, Upper Three Runs, Four Mile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek. Analyses for radionuclides typically include tritium, gross alpha, gross beta, Sr-89,90, Co-60, Cs-137, U-234,235 and 238, and Pu-238,239. All streams listed have detections of gross alpha, gross beta, and tritium. According to the SRS Environmental Report for 1997, the average tritium concentration increased in two streams during 1997. Surface water samples from both Steel Creek (18,100 pCi/L) and Pen Branch (115,000 pCi/L) indicate an increase in the average tritium concentration in 1997.

Five surface water locations are sampled along the Savannah River by SRS. The most upstream sample location, RM-160, detected an average concentration of 137 pCi/L tritium. Lead was detected at this location once during the year at a concentration of 0.012 mg/l. The herbicide 2,4-D

was detected at this location at a concentration of 0.694 ug/l. The EPA drinking water concentration for 2,4-D is 70 ug/l. Sample location RM-150, located where Four Mile Branch discharges to the Savannah River, detected an average tritium concentration of 1390 pCi/L in 1997. The most downstream sample location, RM-120, detected an average tritium concentration of 1100 pCi/L. The EPA drinking water standard for tritium is 20,000 pCi/l. Sample location RM-140 on the Savannah River had the highest detection of mercury at 0.002 ug/l. Chromium and nickel were also detected at this location.

DHEC's Environmental Surveillance and Oversight Program (ESOP) also collects surface water samples from the Savannah River. Sample location SV-2018 is located at the Steel Creek public boat landing. Tritium concentrations at this location exceeded the EPA drinking water standard of 20,000 pCi/L in March 1997, January 1998, February 1998, March 1998, April 1998 and May 1998. The highest tritium concentration at SV-2018 was 30,374 pCi/L in January 1998. Surface water sample locations SV-2015 and SV-2019 (Little Hell Landing) along the Savannah River have also exceeded the EPA drinking water standard for tritium.

Tims Branch, which flows into Upper Three Runs Creek, receives effluent discharges from M-Area and SRTC. The SRS surveillance point located downstream from all releases to Tims Branch detected concentrations of tritium below the nominal short count lower limit of detection (LLD) in 1997. SRS reported gross alpha and gross beta were above detection limits. Nickel, mercury, lead, and chromium were also detected along Tims Branch.

Upper Three Runs Creek receives discharges from the Effluent Treatment Facility, flow from Tims Branch, effluent from the Naval Fuels Facility, and stormwater runoff from F-Area and H-Area. Most of the tritium contamination in Upper Three Runs Creek is released from the Effluent Treatment Facility. The average concentration of tritium detected by SRS in 1997 at the downstream point nearest the Savannah River was 3290 pCi/L. This concentration is 16.5% of the EPA drinking water standard of 20,000 pCi/L. Lead and mercury were detected along Upper Three Runs Creek. The herbicide 2,4-D was detected along Upper Three Runs Creek in 1997 at a concentration of 0.223 ug/l. The highest tritium concentrations detected by DHEC's ESOP program were 30,500 pCi/L (June 1998) and 37,298 pCi/L (February 1997) at surface water sample location SV-325.

Four Mile Branch receives effluent from F-Area, H-Area, C-Area, and groundwater discharges from the F-Area and H-Area seepage basins. According to the SRS Environmental Report for 1997, approximately 53.5 % of the total amount of tritium reaching the Savannah River is transported by Four Mile Branch. The tritium contamination in Four Mile Branch is mainly from the groundwater discharges from the F-Area and H-Area seepage basins along with the MWMF/BGC. Tritium concentrations as high as 617,887 pCi/L have been detected by DHEC's ESOP program in Four Mile Branch near the F- and H-Area seepage basins. SRS reports that nitrate levels in Four Mile Branch range between 1 mg/l and 2 mg/l. Lead and nickel were also detected along Four Mile Branch. Groundwater remediation systems have been installed in both the F-and H-Areas and are operating, however, not all of the Phase I corrective action requirements (as defined by SRS Hazardous and

Mixed Waste Permit) have been met at this time.

Pen Branch receives discharges from K-Area and flow from a tributary to Indian Grave Branch. Surface water contamination in this area is largely sourced by discharges from the K-Area percolation field and seepage basins entering Indian Grave Branch. SRS reports that the 1997 average tritium concentration of 115,000 pCi/L in Pen Branch increased from the average 1996 concentration of 62,200 pCi/L. The total concentration for all alpha-emitting isotopes was 0.23 pCi/L. Lead was detected in Pen Branch at a concentration of 0.044 mg/l once during the year. DHEC's ESOP program detected tritium at surface water sampling location SV-2048 as high as 214,316 pCi/L (September 1997).

Steel Creek receives releases from L-Area effluents and tritium from groundwater discharges from the P-Area seepage basins. Releases also occur when P-Area diverts water from PAR Pond to Steel Creek. Overflows from L-Lake enter Steel Creek. SRS reports that the average tritium concentration in Steel Creek in 1997 was 18,100 pCi/L. This is an increase from the average 1996 tritium concentration of 7540 pCi/L. The average gross alpha concentration was 164 pCi/L. Nickel and lead were also detected in Steel Creek during 1997. DHEC surface water sampling location SV-327, near road 125, detected tritium as high as 8698 pCi/L (February 1998) in Steel Creek. DHEC surface water sampling location SV-2018 is located at the Steel Creek Boat Landing (downstream from where Steel Creek actually discharges to the Savannah River). The EPA drinking water standard for tritium of 20,000 pCi/L was exceeded at SV-2018 twelve times from February 1997 to August 1998. The highest concentration of tritium detected during this time frame was 30,374 pCi/L (January 1998).

Lower Three Runs Creek receives overflow from PAR Pond. Historically, releases also occurred from P-Area and R-Area operations. SRS reported that mean concentrations for gross alpha, tritium, Co-60, and Cs-137 at sampling location L3R-3 (located where PAR Pond discharges to Lower Three Runs Creek) all were below the lower limit of detection. DHEC's ESOP program has detected tritium at surface water sampling location SV-2053 as high as 3172 pCi/L (February 1997). Location SV-2053 (also known as location LTR-02) is located where Par Pond enters Lower Three Runs Creek.

Based on an evaluation by the Department's Bureau of Water (BOW), accessible onsite surface waters such as Upper Three Runs, Four Mile Branch, Pen Branch, and Steel Creek which contain constituents exceeding an MCL should be restricted in such a manner that would minimize the potential for human exposure. The Savannah River, itself, according to the BOW evaluation, because of its volume and the degree of mixing, does not present an unacceptable threat to human health.

AIR

According to the SRS Environmental Report for 1997, a 1993 air emissions inventory conducted at SRS identified approximately 5300 emission sources at SRS, radiological and nonradiological.

As of 1997, there were 194 permitted/exempted non-radiological emission sources at Savannah River Site. Thirty-five of the sources are permitted for toxic air pollutants. SRS monitors facility air emissions at their discharge points by direct measurement, sample extraction and analysis, or process knowledge (i.e. material/mass balance). Major emissions of concern include sulfur dioxide, carbon monoxide, nitrogen oxides, particulate matter smaller than 10 microns, volatile organic compounds, and toxic air pollutants. Arsenic and benzene have been identified as primary potential contributors to offsite exposure. Additionally, gaseous fluorides (such as hydrogen fluoride) and lead are considered to be criteria pollutants. Sources at SRS include diesel engine-powered equipment, No.2 fuel oil generators, powerhouse coal-fired boilers, the DWPF, the CIF, the in-tank precipitation process, groundwater air strippers, soil vapor extraction units, and various other process facilities.

Air dispersion modeling has been conducted for all sources of criteria and toxic pollutants by the Savannah River Technology Center. SRTC's results indicate that all SRS sources are in compliance with applicable air quality standards and regulations. An additional 'check' will be performed on the CIF. As part of the CIF's permitting process, a human health risk assessment will be performed using data obtained from the incinerator's trial burn.

SRS monitors most radionuclides at their discharge point by a combination of direct measurement and/or sample extraction and analysis, depending on the nature of the radionuclides being monitored. Emissions from unmonitored radionuclides (i.e. radionuclides which cannot be measured in effluent streams) such as fission product tritium, carbon-14, and krypton are calculated on a yearly basis. Emissions are estimated from unmonitored sources such as ponds, contaminated land areas, and certain structures. Tritium and tritium oxides constitute most of the total radioactivity released to the atmosphere. In 1997, about 58,000 Ci of tritium was released from SRS.

DOE calculates reference concentrations for radioactive constituents which are based on a 100 mrem exposure and assume continuous exposure at the point of discharge. Air emissions at SRS which have exceeded these concentrations include tritium oxides (from the heavy water rework facilities, reactor facilities, and tritium facilities), americium-241 from F-Area, and Pu-239 from H-Area. However, according to SRS, the offsite dose from all atmospheric releases during 1997 remained below the DOE/EPA atmospheric pathway dose standard of 10 mrem/yr.

Radiological air surveillance at Savannah River Site consists of 19 air surveillance stations onsite or along the site perimeter, three stations approximately 25 miles from the site perimeter, and one approximately 100 miles from the site perimeter at Savannah, Georgia. Analysis is conducted for gross alpha and gross beta, gamma-emitting radionuclides, tritium, Pu-238 and Pu-239, and total strontium. In general, 1997 gross beta concentrations at all locations were an order of magnitude above the minimum detectable concentration. Gross alpha concentrations were slightly above the minimum detectable concentration. According to the SRS Environmental Data for 1997, tritium was the only specific radionuclide routinely detectable at the site perimeter. The highest site perimeter concentration of tritium was at D-Area at approximately 64.5 pCi/m^3. Off-site the highest concentration was at the 25-mile radius location at the Augusta Lock and Dam 614 at ~ 23.1 pCi/m^3. The concentration at the 100-mile radius location was ~ 5.44 pCi/m^3. Cs-137 and Co-60 were

slightly higher than the minimum detectable concentration at two site perimeter locations: the Barnwell Gate and Highway 21/167. In general, plutonium and total strontium were near or below the minimum detectable concentration. The highest Pu-238 and -239 concentrations were at the 100-mile radius location (Savannah, GA).

Indoor Air Quality

Indoor air quality may be a potential concern for buildings located over groundwater plumes containing volatile organic compounds (VOCs).[12] In the F-Area and the A/M-Area, for example, some buildings are located above groundwater contaminated with chlorinated volatiles. In addition, the vadose zone in a portion of M-Area is contaminated with vapor-phase chlorinated volatiles. Data contained in a recent letter from SRS (Odum to Frasier, 2-12-99) indicates that the estimated maximum workplace concentrations surrounding the A/M-Area soil vapor extraction units, while not exceeding an OSHA standard, exceed the ambient air RBC for trichloroethylene, perchloroethylene, carbon tetrachloride, and chloroform. Indoor air concentrations of VOCs cannot, however; be extrapolated from the outdoor maximum workplace concentrations cited in the above referenced letter. A better understanding of indoor air concentrations could be obtained from direct measurements (the ideal case) or an appropriate fate and transport model.

OTHER SURVEILLANCE PROGRAMS

In addition to the monitoring and surveillance programs already established for surface water, groundwater, soils/sediments, and air, SRS has established several other radiological and non-radiological surveillance programs. These include radiological surveillance for wild game (deer, feral hogs, and turkeys) caught on site, freshwater and marine fish from the Savannah River, and terrestrial food products such as meat (beef or chicken), fruit, vegetables, and milk, and non-radiological surveillance programs for fish.

Deer, Hogs, and Turkeys

SRS holds annual hunts to control deer and feral hog populations onsite. However, before an animal is released to a hunter, the animal is screened for Cs-137 using portable sodium iodide detectors. SRS calculates the dose that would be received from consumption of the individual animal and the hunter's cumulative annual dose to ensure that DOE's 'all pathways' dose limit of 100 mrem/yr is not exceeded. In 1997, the maximum concentration of Cs-137 in deer and feral hog meat was approximately 22 pCi/g and 8 pCi/g, respectively. The average concentration was 5 pCi/g for deer meat and 2 pCi/g for hog meat. In 1997, 1685 deer and 109 feral hogs were taken from the site through the controlled hunt program.

Wild turkeys onsite have been trapped and used to repopulate other areas of the state. Turkeys with

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12 The February 5, 1999 Interim Final Guidance for RCRA Corrective Action Environmental Indicators includes indoor air as a media which must be addressed in the CA725 Current Human Exposures Under Control determination. Recent evidence suggest that unacceptable indoor air concentrations can exist in structures located above or near groundwater with volatile contaminants.

Cs-137 concentrations exceeding 25 pCi/g are not released. The maximum Cs-137 concentration found in captured wild turkeys was 6 pCi/g in 1997.

Potentially, unscreened animals which exceed DOE's release limits could migrate off-site. However, according to site officials, in the last 10 years, only one animal (a deer) caught as part of the surveillance program has exceeded DOE's release limit.

Fish

Non-radiological surveillance: Fish of edible species are collected from SRS streams/ponds and the Savannah River and analyzed for methylmercury. The highest onsite concentration found in 1997 was 2.82 μg/g in a bass from Lower Three Runs Creek. The highest offsite concentration was 1.30 μg/g in a bass from Steel Creek River Mouth. Both values exceed the EPA Region III RBC value for methylmercury in fish which is 0.14 mg/kg.

Radiological surveillance: Freshwater fish from three categories are collected at seven locations onsite and nine locations on the Savannah River. Fish from each category at each location are composited and analyzed for gross alpha and beta activity, Cs-137, total strontium, and tritium. In 1997, gross beta was detected in edible portions of fish samples from all locations, both onsite and offsite. The onsite high was approximately 51.8 pCi/g in a bass from Pond B and the offsite high was approximately 3.99 pCi/g in a catfish from the mouth of Steel Creek. Cs-137 was detected in fish from all sampling locations, onsite and offsite. The onsite high was ~ 92.1 pCi/g in a bass from Pond B and the offsite high was ~ 9.20E-01 pCi/g in a bass from the mouth of Four Mile Creek. Additionally, total strontium activity was detected in fish from six out of seven offsite sample locations and tritium was detected in fish from five of the seven sampling locations. The high concentration for each constituent was found in fish collected from the mouth of Four Mile Creek (total strontium at ~ 5.86E-02 and tritium at ~ 26.7 pCi/g). Finally, marine fish are collected from the U.S. Highway 17A bridge location on the Savannah River. Again, gross beta was detected in all sample composites, the high being approximately 2.46 pCi/g. Cs-137 was also detected with the highest activity being approximately 9.52E-02 pCi/g. On May 14, 1996, DHEC released a fish consumption advisory[13] (Attachment 5)for the Savannah River for all species of fish. This advisory remains in effect and is based on fish testing which identified elevated levels of Cs-137 and Sr-90. This advisory applies to portions of the Savannah River reaching from Beech Island in Aiken County to Webb Wildlife Center in Hampton County.

Terrestrial Food Products

Samples of meat, fruit, green vegetables, and milk are collected from four quadrants (approximately 15 km beyond the site perimeter) and one control location approximately 25 miles from the site

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13 Mercury concentrations in many South Carolina surface waters have led South Carolina to issue a fish consumption advisory which has been in place since 1995. This advisory was amended in 1996, for a portion of the Savannah River, to include Sr-90 and Cs-137 and was expanded to all species of fish.

boundary. Samples are collected annually except for milk which is collected monthly. In 1997, the highest concentrations of radionuclides (in food products other than milk), were found, for Cs-137, in beef from the northwest quadrant (~ 6.43E-02 pCi/L); for tritium, in beef in the northeast quadrant (~ 2.02E-01 pCi/L); for Sr-89,-90, in greens in the northeast quadrant (~ 7.73E-02 pCi/L); and for Pu-239, in beef at the control location (~ 2.94E-04 pCi/L). For milk, the highest radionuclide concentrations were approximately 3.73 pCi/L of Cs-137 in milk from Denmark, SC, 7.89E-2 pCi/L of tritium in milk from Jackson, SC, 4.03 pCi/g Co-60 in milk from Waynesboro, GA, and the highest Sr-90 concentration was 4.89 pCi/g in milk from Waynesboro, GA.

Additional sampling should be performed to determine if any terrestrial food products in the Creek Plantation area have been affected by contamination originating from SRS.

V. STATUS CODE RECOMMENDATION FOR CA725:

Releases of volatile organics, metals, tritium, and other radionuclides have affected groundwater, surface water, air, and soils/sediments at SRS. Surface water, soils, and sediments have been affected beyond the facility boundary. However, physical and administrative controls are in place to mitigate the potential for human exposure to contaminated media. Therefore, it is recommended that CA725 YE be entered into RCRAInfo. Even with the CA725 YE determination, some follow-up actions are still necessary. Section VIII includes a summary of the affected media for which follow-up action is needed along with the rationale for the CA725 YE determination.

VI. GROUNDWATER RELEASES CONTROLLED DETERMINATION (CA750):

There are five (5) status codes listed under CA750:

1) YE Yes, applicable as of this date.
2) NA Previous determination no longer applicable as of this date.
3) NR No releases to groundwater.
4) NO Facility does not meet definition.
5) IN More information needed.

The first three (3) status codes listed above were defined in the January 1995 Data Element Dictionary for RCRIS. The last two (2) status codes were defined in the June 1997 Data Element Dictionary.

The status codes for CA750 are designed to measure the adequacy of actively (e.g., pump and treat) or passively (e.g., natural attenuation) controlling the physical movement of groundwater contaminated with hazardous constituents above relevant action levels. The designated boundary (e.g., the facility boundary, a line upgradient of receptors, the leading cleanup standards, etc.) is the point where the success or failure of controlling the migration of hazardous constituents is measured for active control systems. Every contaminated area at the facility must be evaluated and found to

have the migration of contaminated groundwater before a "YE" status code can be entered.

If contaminated groundwater is not controlled in any area(s) of the facility, the NO status code should be entered. If there is not enough information at certain areas to make an informed decision as to whether the groundwater releases are controlled, then the IN status code should be entered. If an evaluation determines that there are both uncontrolled groundwater releases for certain areas/units of groundwater contamination (IN), then the priority for the EI recommendation should be the NO status code.

In Region 4's opinion, the previous relevance of NA as a meaningful status code is eliminated by the June 1997 Data Element Dictionary's inclusion of NO and IN to the existing YE and NR status codes. In other words, YE, NR, NO, and IN cover all of the scenarios possible in an evaluation or reevaluation of a facility for CA750. Therefore, it is Region 4's opinion that only YE, NR, NO, and IN should be utilized to categorize a facility for CA725. No facility in Region 4 should carry a NA status code.

This evaluation for CA750 is the first formal evaluation performed for SRS. Please note that CA750 is based on the adequate control of all contaminated groundwater at the facility.

The following discussions, interpretations, and conclusions on contaminated groundwater at the facility are based on the following reference documents:

1) 1992 RCRA Part B Permit Renewal Application, Vols. II-VII, XIV, and XXIII

2) 1988 RCRA Part B Permit Application, Vol. X

3) Hazardous and Mixed Waste Permit for SRS, issued September 5, 1995

4) Memorandums from Bureau of Land and Waste Management's RCRA and FFA Engineers and Hydrogeologists assigned to SRS, dated July 1998

5) SRS Environmental Report for 1997, WSRC-TR-97-00322

6) SRS Environmental Report for 1997 Summary, WSRC-TR-97-00323

7) SRS Environmental Data for 1997, WSRC-TR-97-000324

8) H-Area Hazardous Waste Management Facility Corrective Action Report - Third and Fourth Quarter 1997, dated March 1998

9) F-Area Hazardous Waste Management Facility Corrective Action Report - Third and Fourth Quarter 1997, dated March 1998

10) RFI/RI Work Plan for the F and H Areas Inactive Process Sewer Lines, dated March 1992

11) Mixed Waste Management Facility Groundwater Monitoring Report - Fourth Quarter 1997 and 1997 Summary, dated March 1998

12) Work Plan RFI/RI Report for Old Radioactive Waste Burial Ground (ORWBG), Vols. I and II, Rev. 0, dated November 1997

13) Burial Ground Complex Field Investigation Preliminary Data Report #1, dated January 1995

14) Burial Ground Complex Field Investigation Preliminary Data Report #2, dated January 1996

15) Lower Savannah District's Environmental Surveillance and Oversight Program's analytical results of surface water tritium sampling (electronic format)

16) DOE/SRS-SCDHEC Memorandum of Agreement, dated April 8, 1985 and Amendment, dated May 5, 1988

17) Settlement Agreement 87-27-SW, dated May 1, 1987 and Amendment, dated June 14, 1989

VII. STATUS CODE RECOMMENDATION FOR CA750:

Recommend Option 3: CA750 NO: Releases to groundwater have occurred, and all groundwater releases at the facility are not controlled.

Based on data contained in the documents referenced in Section V and summarized in the groundwater portion of Section IV, releases from SWMUs and/or AOCs have contaminated groundwater at concentrations above relevant action levels such as EPA's Drinking Water Standards (MCLs).

Control measures are not yet effective in controlling migration of contaminated groundwater. Because all groundwater contamination at or emanating from the facility is not controlled, it is recommended that CA750 NO be entered.

VIII. SUMMARY OF FOLLOW-UP ACTIONS:

The solid waste management units at SRS are in varying stages of the corrective action process. Interim actions and final corrective measures have been initiated in many areas of the facility. However, there are solid waste management units for which characterization has not yet been completed. SRS and the Department continue to work through the Federal Facilities Agreement (FFA) program to investigate and fully assess the extensive list of solid waste management units on site. Due to the large number of SWMUs/OUs at SRS, assessment of these units is being conducted through a prioritized schedule under the FFA program. Please note that SWMU accessibility has been evaluated and the Department has

determined that the potential for accidental human exposure is minimal due to the physical (signs, markers, etc.) and administrative (procedures) controls in place.

The potential for human exposure to contaminants through the consumption of wild game is being evaluated by the FFA in their investigation of the Savannah River Swamp Integrated Operable Unit.

Corrective action systems are in place for contaminated groundwater and/or soils at the permitted post-closure facilities at SRS. However, because not all of the systems are fully operational at this time, hydraulic control has not been achieved for each contaminant plume. Until hydraulic control is achieved for the contaminant plume associated with the F- and H-Area seepage basins, for example, it will continue to be a major contributor to tritium levels in onsite and ultimately offsite surface waters. The Department continues to work closely with SRS to attain effective groundwater monitoring and/or remediation systems at the permitted units.

Indoor air quality was identified as a potential concern for buildings located over groundwater plumes containing VOCs. All buildings above all known VOC plumes were evaluated to determine if the potential for human exposure existed. Most buildings were eliminated as a concern for one or more of the following reasons: positive pressure, unoccupied or infrequent use, scheduled for decommissioning and demolition by 2006, foundation type, or located 100 feet or more (vertically or horizontally) from the source of contamination. Three buildings, however, require further investigation - the Engineering Assistance Facility (723-A) in A/M Area, the Production Control Facility (772-1F) in F-Area, and the Control Laboratory (F-Lab) in F-Area. The Department, via the RCRA permit, is requiring a Tier 2 and/or Tier 3 investigation as per the OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), dated November 2002, EPA530-D-02-004, or an equivalent investigation as approved by the Department. In the interim, the site is to be in compliance with OSHA requirements for these buildings. The Department also recommends that trailer skirting be checked to verify adequate ventilation.

Accessible onsite surface waters such as Upper Three Runs, Four Mile Branch, Pen Branch, and Steel Creek which contain constituents exceeding an MCL have been posted with signs warning that hazardous and radioactive constituents may be present. These signs have been located at access points to the streams (i.e. at the creek mouths and public road crossings). Consideration should be given to posting the existing fish advisory at the creek mouths and other public access points along the affected portions of the Savannah River (i.e. boat landings).

Discharges to surface waters have contaminated soils/sediments at the Savannah River Swamp/Creek Plantation to the extent that radionuclide concentrations exceed screening-level risk-based activities calculated at the 1E-4 risk level. Additional sampling of the Creek Plantation/Savannah River Swamp soils/sediments will be required to determine the full extent of vertical and horizontal contamination. Pending the outcome of the investigation, the final remedy may involve a removal action, stabilization, posting, or some other control measure to prevent human exposure to the contaminated soils/sediments. In the interim, signs have been placed around the contaminated area to prevent human exposures. Sign placement is to be verified by the Department. More signs may be needed if the Department finds the current number and arrangement inadequate.

Additional recommendations:

Currently, for onsite and off-site sediments and off-site soils there is insufficient information to determine if non-radiological constituents contribute to potential human exposures. Available SRS non-radiological sediment data, as presented, could not be compared to risk-based screening values. Preliminary SCDHEC data, indicates that, for most parameters sampled, sediment concentrations fall below the screening values. However, the parameter list should be expanded to include all constituents for which there is an available screening value. Off-site non-radiological soil data is not available. Sampling at off-site radiological soil sampling locations could be expanded to include non-radiological parameters that could likely be transported off-site via air or surface water deposition.

Additional off-site radiological sampling is recommended to adequately characterize potentially affected media. For example, sampling should be performed to determine if soils, any terrestrial food products, or private wells existing in the Creek Plantation area have been affected by contamination originating from SRS.

CC: Ken Taylor, Division of Hydrogeology, BLWM
Rick Caldwell, Region 5 EQC
Caron Falconer, RCRA Programs Branch, EPA Region 4
Bill Maloney, WSRC

Attachments

Attachment 1

Revision.1 Appendix C for Fiscal Year 2005

C.2: RCRA/CERCLA Units Sorted by Unit Name

RCRA/CERCLA Unit	PREscore
211-FB Pu-239 Release, 081-F* SRS Index Number(s): 43 CERCLIS Number(s): 97	0
313-M and 320-M Inactive Clay Process Sewers to Tims Branch, NBN SRS Index Number(s): 234 CERCLIS Number(s): 92	PNA
A-001 Outfall, NBN SRS Index Number(s): 481 CERCLIS Number(s): 62	PNA
A-Area Ash Pile, 788-0A SRS Index Number(s): 236 CERCLIS Number(s): 62	PNA
A-Area Burning/Rubble Pits, 731-A, -1A and A-Area Rubble Pit, 731-2A SRS Index Number(s): 46, 45, 49 CERCLIS Number(s): 19	31.89
A-Area Coal Pile Runoff Basin, 788-3A SRS Index Number(s): 47 CERCLIS Number(s): 62	17.94
A-Area Process Sewer Lines as Abandoned*, NBN SRS Index Number(s): 562 CERCLIS Number(s): 62	PNA
Area on North Side of Building 105-5, and Laydown Area North of 105R, and Release from the Decontamination of R-Area Reactor Disassembly Basin. NBN SRS Index Number(s): 231, 233, 513 CERCLIS Number(s): CNA	PNA
C-Area Burning/Rubble Pit, 131-C and Old C-Area Burning/Rubble Pit, NBN SRS Index Number(s): 51, 566 CERCLIS Number(s): 31	17.94
C-Area Process Sewer Lines as Abandoned*, NBN SRS Index Number(s): 555 CERCLIS Number(s): 79	PNA
C-Area Reactor Area Cask Car RailRoad Tracks as Abandoned*, NBN SRS Index Number(s): 475 CERCLIS Number(s): 79	PNA
C-Area Reactor Discharge Canal*, NBN SRS Index Number(s): 511 CERCLIS Number(s): 84	PNA
C-Area Reactor Groundwater*, NBN SRS Index Number(s): 146 CERCLIS Number(s): 82	PNA
Central Shops Groundwater Operable Unit, NBN SRS Index Number(s): 567 CERCLIS Number(s): 98	PNA
CMP Pits, 080-170G, -171G, -180G, -181G, -182G, -183G, and 190G SRS Index Number(s): 61, 62, 63, 64, 65, 66, 67 CERCLIS Number(s): 24	33.55
Combined Spills from 105-K, 106-K, and 109-K, NBN SRS Index Number(s): 514 CERCLIS Number(s): 90	PNA

* Unit that does not require a RCRA Permit modification.
NA PREscore not applicable.
PNA PREscore not available

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Revision.1 Appendix C for Fiscal Year 2005

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RCRA/CERCLA Unit	PREscore
Combined Spills from 211-H, NBN SRS Index Number(s): 260 CERCLIS Number(s): 61	PNA
Combined Spills from 221-F, NBN SRS Index Number(s): 485 CERCLIS Number(s): 88	PNA
Combined Spills from 221-H, NBN SRS Index Number(s): 512 CERCLIS Number(s): 61	PNA
Combined Spills North of Building 105-R, NBN SRS Index Number(s): 517 CERCLIS Number(s): 95	PNA
D-Area Asbestos Pit, 080-20G SRS Index Number(s): 211CERCLIS Number(s): CNA	PNA
D-Area Ash Basin Wetlands, NBN SRS Index Number(s): 569 CERCLIS Number(s): 63	PNA
D-Area Coal Pile Runoff Basin, 489-D SRS Index Number(s): 69 CERCLIS Number(s): 63	17.94
D-Area Groundwater Operable Unit (D-Area Upgradient Sources), NBN SRS Index Number(s): 520 CERCLIS Number(s): 63	PNA
D-Area Process Sewer Lines as Abandoned*, NBN SRS Index Number(s): 558 CERCLIS Number(s): 63	PNA
D-Area Waste Oil Facility, 484-D SRS Index Number(s): 70 CERCLIS Number(s): 63	14.29
D006 Petroleum Release Site, NBN SRS Index Number(s): 570 CERCLIS Number(s): 63	PNA
Ditch to Outfall H-13 (Tributary to Fourmile Creek), NBN SRS Index Number(s): 274 CERCLIS Number(s): 61	PNA
ECODS B-3 (East of B Area, South of Road C), NBN and ECODS B-5, NBN SRS Index Number(s): 528 530 CERCLIS Number(s): CNA	PNA
ECODS C-1 (Near C-Area Reactor Discharge Canal), NBN SRS Index Number(s): 522CERCLIS Number(s): CNA	PNA
ECODS L-3 (East of L Area) SRS Index Number(s): 537CERCLIS Number(s): CNA	PNA
ECODS N-1 (South of N Area), NBN SRS Index Number(s): 525 CERCLIS Number(s): 78	PNA

* Unit that does not require a RCRA Permit modification.
NA PREscore not applicable.
PNA PREscore not available

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Revision.1 Appendix C for Fiscal Year 2005

C.2: RCRA/CERCLA Units Sorted by Unit Name

RCRA/CERCLA Unit	PREscore
F-Area Inactive Process Sewer Lines from Building to the Security Fence, 081-1F SRS Index Number(s): 141 CERCLIS Number(s): 88	18.02
F-Area Process Sewer Lines as Abandoned*, NBN SRS Index Number(s): 563 CERCLIS Number(s): 88	PNA
F-Area Retention Basin*, 281-08F SRS Index Number(s): 280 CERCLIS Number(s): 23	PNA
F-Area Tank Farm*, NBN (Reference DOE Letter OD-03-179 for list of 12 areas comprising this unit) SRS Index Number(s): 263, 283, 376, 380, 381 CERCLIS Number(s): 23	PNA
Fourmile Branch Integrator Operable Unit (Including the Un-Named Tributary of Fourmile Branch South of C Area), NBN SRS Index Number(s): 504 CERCLIS Number(s): 84	NA
G-Area Oil Seepage Basin, 761-13G SRS Index Number(s): 77 CERCLIS Number(s): 86	3.88
General Separations Area Eastern Groundwater Operable Unit, NBN SRS Index Number(s): 549 CERCLIS Number(s): 46	PNA
General Separations Area Western Groundwater Operable Unit, NBN SRS Index Number(s): 575 CERCLIS Number(s): 85	13.67
Gunsite 012 Rubble Pile (NBN), Rubble Pile Across from Gunsite 012 (NBN), and ECODS G-3 (NBN) SRS Index Number(s): 163, 337, 544 CERCLIS Number(s): 103	PNA
Gunsite 218 Rubble Pile, 631-23G SRS Index Number(s): 39 CERCLIS Number(s): 104	0.13
H-Area Coal Pile Runoff Basin, 289-H SRS Index Number(s): 79 CERCLIS Number(s): 61	17.94
H-Area Inactive Process Sewer Lines from Building to Manhole P-44 Fence, 081-H SRS Index Number(s): 142 CERCLIS Number(s): 61	18.02
H-Area Process Sewer Lines as Abandoned (located in Fourmile Branch Watershed)*, NBN SRS Index Number(s): 554 CERCLIS Number(s): 61	PNA
H-Area Process Sewer Lines as Abandoned (located in Upper Three Runs Watershed)*, NBN SRS Index Number(s): 564 CERCLIS Number(s): 61	PNA
H-Area Retention Basins, 281-1H, and -2H and H-Area Retention Basin (Including the Former 281-7H Basin), 281-8H* SRS Index Number(s): 294, 295, 293 CERCLIS Number(s): 61	PNA

* Unit that does not require a RCRA Permit modification.
NA PREscore not applicable.
PNA PREscore not available

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Revision.1 Appendix C for Fiscal Year 2005

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RCRA/CERCLA Unit	PREscore
H-Area Tank Farm*, 241-H (Reference DOE Letters OD-02-208 and EB-04-237 for list of 10 areas comprising this unit) SRS Index Number(s): 262, 264, 275, 298, 375, CERCLIS Number(s): 89	PNA
Hydrofluoric Acid Spill*, 631-4G SRS Index Number(s): 82 CERCLIS Number(s): 75	1.81
K-Area Process Sewer Lines as Abandoned*, NBN SRS Index Number(s): 572 CERCLIS Number(s): 90	PNA
K-Area Reactor Area Cask Car Railroad Tracks as Abandoned*, NBN SRS Index Number(s): 476 CERCLIS Number(s): 90	PNA
K-Area Reactor Discharge Canal*, NBN SRS Index Number(s): 460 CERCLIS Number(s): 74	PNA
K-Area Reactor Groundwater (Including Tritium Anomaly)*, NBN SRS Index Number(s): 519 CERCLIS Number(s): 99	7.47
K-Area Sludge Land Application Site, 761-4G SRS Index Number(s): 89 CERCLIS Number(s): 105	1.98
L-Area Ash Basin, 188-0L SRS Index Number(s): 148 CERCLIS Number(s): 91	PNA
L-Area Northern Groundwater, NBN SRS Index Number(s): 503 CERCLIS Number(s): 100	PNA
L-Area Process Sewer Lines as Abandoned*, NBN SRS Index Number(s): 560 CERCLIS Number(s): 91	PNA
L-Area Reactor Area Cask Car Railroad Tracks as Abandoned*, NBN SRS Index Number(s): 479 CERCLIS Number(s): 91	PNA
L-Area Rubble Pit, 131-1L SRS Index Number(s): 98 CERCLIS Number(s): 106	0.22
L-Area Rubble Pit, 131-4L SRS Index Number(s): 99 CERCLIS Number(s): 107	12.3
L-Area Southern Groundwater, NBN SRS Index Number(s): 487 CERCLIS Number(s): 77	PNA
Low Level Radioactive Drain Lines*, 772-F SRS Index Number(s): 308 CERCLIS Number(s): 88	PNA
Low Level Radioactive Waste Disposal Facility*: The non-hazardous waste disposal portion of 643-7E (including Combined Spills from 643-G. NBN), 643-7E SRS Index Number(s): 571, 266 CERCLIS Number(s): 101	PNA

* Unit that does not require a RCRA Permit modification.
NA PREscore not applicable.
PNA PREscore not available

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CNA: CERCLIS Number not assigned

Revision.1 Appendix C for Fiscal Year 2005

C.2: RCRA/CERCLA Units Sorted by Unit Name

RCRA/CERCLA Unit	PREscore
Lower Three Runs Integrator Operable Unit*, NBN SRS Index Number(s): 505 CERCLIS Number(s): 81	NA
M-Area Settling Basin Inactive Process Sewers to Manhole 1, 081-M (Including Potential Release of TCT, TET TCE, HNO3, U, Heavy Metals from 321-M Abandoned Sewer Line, NBN) SRS Index Number(s): 100, 326 CERCLIS Number(s): 92	1.79
Miscellaneous Chemical Basin/Metals Burning Pit, 731-4A and -5A SRS Index Number(s): 101, 102 CERCLIS Number(s): 28	4.26
N-Area Process Sewer Lines as Abandoned*, NBN SRS Index Number(s): 565 CERCLIS Number(s): 93	PNA
Neutralization Sump, 678-T SRS Index Number(s): 310CERCLIS Number(s): 96	PNA
Old R-Area Discharge Canal, NBN (also known as Joyce Branch)* SRS Index Number(s): 312 CERCLIS Number(s): 81	PNA
P-Area Process Sewer Lines as Abandoned*, NBN SRS Index Number(s): 557 CERCLIS Number(s): 94	PNA
P-Area Reactor Area Cask Car Railroad Tracks as Abandoned*, NBN SRS Index Number(s): 477 CERCLIS Number(s): 94	PNA
P-Area Reactor Discharge Canal*, NBN SRS Index Number(s): 462 CERCLIS Number(s): 71	PNA
P-Area Reactor Groundwater*, NBN SRS Index Number(s): 143 CERCLIS Number(s): 102	PNA
Par Pond (Including the Pre-Cooler Ponds and Canals)*, 685-G SRS Index Number(s): 110 CERCLIS Number(s): 35	50.34
Par Pond Sludge Land Application Site, 761-5G SRS Index Number(s): 111 CERCLIS Number(s): 108	0.04
Pen Branch Integrator Operable Unit (Including Indian Grave Branch), NBN SRS Index Number(s): 506 CERCLIS Number(s): 74	NA
Potential Release from C-Area Disassembly Basin*, 105-C SRS Index Number(s): 240 CERCLIS Number(s): 79	PNA
Potential Release from C-Area Reactor Cooling Water System*, 186/190-C SRS Index Number(s): 242 CERCLIS Number(s): 79	PNA
Potential Release from K-Area Disassembly Basin*, 105-K SRS Index Number(s): 301 CERCLIS Number(s): 90	PNA

* Unit that does not require a RCRA Permit modification.
NA PREscore not applicable.
PNA PREscore not available

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CNA: CERCLIS Number not assigned

Revision.1 Appendix C for Fiscal Year 2005

C.2: RCRA/CERCLA Units Sorted by Unit Name

RCRA/CERCLA Unit	PREscore
Potential Release from K-Area Reactor Cooling Water System*, 186/190-K SRS Index Number(s): 302 CERCLIS Number(s): 90	PNA
Potential Release from L-Area Disassembly Basin*, 105-L SRS Index Number(s): 303 CERCLIS Number(s): 91	PNA
Potential Release from L-Area Reactor Cooling Water System*, 186/190-L SRS Index Number(s): 305 CERCLIS Number(s): 91	PNA
Potential Release from P-Area Disassembly Basin*, 105-P SRS Index Number(s): 314 CERCLIS Number(s): 94	PNA
Potential Release from P-Area Reactor Cooling Water System*, 186/190-P SRS Index Number(s): 316 CERCLIS Number(s): 94	PNA
Potential Release from R-Area Disassembly Basin*, 105-R SRS Index Number(s): 330 CERCLIS Number(s): 95	PNA
Potential Release of $NaOH/H_2SO_4$ from 183-2R, NBN SRS Index Number(s): 324 CERCLIS Number(s): 95	PNA
R-Area Ash Basin, 188-0R SRS Index Number(s): 329 CERCLIS Number(s): 95	PNA
R-Area Groundwater, NBN and Cooling Water Effluent Sump, 107-R SRS Index Number(s): 288, 271 CERCLIS Number(s): 95	PNA
R-Area Process Sewer Lines as Abandoned*, NBN SRS Index Number(s): 556 CERCLIS Number(s): 95	PNA
R-Area Reactor Area Cask Car Railroad Tracks as Abandoned*, NBN SRS Index Number(s): 478 CERCLIS Number(s): 95	PNA
Road A Chemical Basin, 904-111G SRS Index Number(s): 125 CERCLIS Number(s): 64	10.14
Salvage Yard, 741-A SRS Index Number(s): 340CERCLIS Number(s): 92	PNA
Sandblast Area CMF-001, NBN SRS Index Number(s): 343 CERCLIS Number(s): 88	PNA
Sandblast Area CMH-001, NBN SRS Index Number(s): 344 CERCLIS Number(s): 61	PNA
Sandblast Area CMH-002, NBN SRS Index Number(s): 346 CERCLIS Number(s): 61	PNA

* Unit that does not require a RCRA Permit modification.
NA PREscore not applicable.
PNA PREscore not available

SRS Index Number is a unique identifier assigned to each individual RCRA/CERCLA Unit.
This number is used by SRS for tracking and is not meant to imply a ranking or priority.

CERCLIS: USEPA Comprehensive Environmental Response, Compensation, and Liability Identification System
CNA: CERCLIS Number not assigned

Revision.1 Appendix C for Fiscal Year 2005

C.2: RCRA/CERCLA Units Sorted by Unit Name

RCRA/CERCLA Unit	PREscore
Savannah River and Floodplain Swamp Integrator Operable Unit (Including Steel Creek Swamp and Beaver Dam Creek), NBN SRS Index Number(s): 508 CERCLIS Number(s): 69	NA
Spill on 01/12/87 of <100 Gm of Mercury North of 211-H, NBN SRS Index Number(s): 374 CERCLIS Number(s): 61	PNA
Spill on 02/01/57 of Unknown of Seepage Basin Pipe Leak from 904-44G*, NBN SRS Index Number(s): 225CERCLIS Number(s): CNA	PNA
Spill on 02/01/83 of 50 Gal of Oil - Rad*, NBN SRS Index Number(s): 391 CERCLIS Number(s): 88	PNA
Spill on 02/25/85 of 20000 CM of Water Vapor - Rad*, NBN SRS Index Number(s): 394 CERCLIS Number(s): 88	PNA
Spill on 04/24/91 of .11 Ci of Pu 239, 772-1F* SRS Index Number(s): 414 CERCLIS Number(s): 88	PNA
Spill on 05/01/57 of 125 FT^2 of Rad Liquid from Solvent Trailer*, NBN SRS Index Number(s): 200CERCLIS Number(s): CNA	PNA
Spill on 05/26/88 of 10 Gal of Ethylene Glycol-Rad from 772-F*, NBN SRS Index Number(s): 429 CERCLIS Number(s): CNA	PNA
Spill on 06/01/59 of <1 CI of Segregated Solvent from 211-F*, NBN SRS Index Number(s): 435 CERCLIS Number(s): 88	PNA
SRL 904-A Process Trench, 904-A and Spill on 12/01/71 of 1000 Gal of Rad Water from 773-A, NBN* SRS Index Number(s): 131, 387 CERCLIS Number(s): 62	0
Steed Pond, NBN SRS Index Number(s): 456 CERCLIS Number(s): 70	PNA
Steel Creek Integrator Operable Unit (Including L Lake, NBN and L-Area Reactor Discharge Canal, NBN) SRS Index Number(s): 509CERCLIS Number(s): 71	NA
Stormwater Outfall A-013, NBN SRS Index Number(s): 483 CERCLIS Number(s): 62	PNA
Stormwater Outfall A-024, NBN SRS Index Number(s): 458 CERCLIS Number(s): 62	PNA
TNX Outfall Delta, Lower Discharge Gully. and Swamp, NBN SRS Index Number(s): 500 CERCLIS Number(s): 96	21.67

* Unit that does not require a RCRA Permit modification.
NA PREscore not applicable.
PNA PREscore not available

SRS Index Number is a unique identifier assigned to each individual RCRA/CERCLA Unit.
This number is used by SRS for tracking and is not meant to imply a ranking or priority.

CERCLIS: USEPA Comprehensive Environmental Response, Compensation, and Liability Identification System
CNA: CERCLIS Number not assigned

Revision.1 Appendix C for Fiscal Year 2005

C.2: RCRA/CERCLA Units Sorted by Unit Name

RCRA/CERCLA Unit	PREscore
TNX-Area Process Sewer Lines and Tile Fields as Abandoned*, NBN SRS Index Number(s): 559 CERCLIS Number(s): 96	PNA
Underground Sump 321 M #001 321-M SRS Index Number(s): 465CERCLIS Number(s): 92	PNA
Underground Sump 321 M #002 321-M SRS Index Number(s): 466CERCLIS Number(s): 92	PNA
Upper Three Runs Integrator Operable Unit (Including Tims Branch), NBN SRS Index Number(s): 510 CERCLIS Number(s): 70	NA
X-001 Outfall Drainage Ditch, NBN SRS Index Number(s): 467 CERCLIS Number(s): 96	PNA

* Unit that does not require a RCRA Permit modification.
NA PREscore not applicable.
PNA PREscore not available

SRS Index Number is a unique identifier assigned to each individual RCRA/CERCLA Unit.
This number is used by SRS for tracking and is not meant to imply a ranking or priority.

CERCLIS: USEPA Comprehensive Environmental Response, Compensation, and Liability Identification System
CNA: CERCLIS Number not assigned

Attachment 2

interoffice
MEMORANDUM

to: Crystal D. Rippy
from: Tracy Shelley, M.S.
subject: Health Consultation Creek Plantation/Savannah River Swamp
date: December 6, 1999

The Division of Health Hazard Evaluation was asked by the Division of Hazardous and Infectious Waste Management to evaluate the risk posed by soil contaminated with cesium-137, strontium-89,90, and cobalt-60. Creek Plantation is privately-owned property between Steel Creek Landing and Little Hell Landing along the Savannah River. The upper part of the property where there are homes, is fairly flat. The edge of the property then slopes down toward the Savannah River. There are no homes in the swampy area. The area where the samples were collected is underwater during the winter months and is not easily accessible. A couple pictures of the area are included. SRS has collected soil samples in this area every five years since 1974. A comprehensive survey, typically consisting of 54 off-site samples collected from 10 sampling trails along the border with the Savannah River, is done every five years. More limited sampling is done in the intervening years.

The data used in this health consultation were collected by SRS in 1996 and SCDHEC in 1998. In 1996, a comprehensive survey was conducted of the Creek Plantation area which consisted of shallow soil samples (0-3 inches) and vegetation samples at each sample location. The 1998 samples consisted of ten samples collected along a transect from near the edge of the flood plain to about 200 feet from the Savannah River (according to Figure 2 from ESOP report). The 1998 samples were reported as sediment samples rather than soil.

The highest concentration of cesium-137 (98.8 pCi/g) was detected in one of the 1996 SRS samples. The highest concentration of cesium in the 1998 SCDHEC samples was 5.54 pCi/g. Cobalt was present in some of the 1996 soil samples, but below 1.0 pCi/g in every sample. Cobalt was not detected in the 1998 SCDHEC sediment samples. Although these samples indicate impact from the SRS site, the levels of radionuclides in this area of Creek Plantation are low and would pose minimal health risk if exposures occurred. Exposure is unlikely to occur because the area is remote, well vegetated, and covered with water at least part of the year. If a hunter or trespasser did come in contact with the soil at these levels, the radiation dose from the cesium-137 would be less than one millirem a year. Normal background exposure is around 100 mrem. The exposure dose is so small that it would not contribute significantly to a person's typical background dose of radiation and therefore, poses minimal health risk. The dose of radiation one could get from this soil would be insignificant.

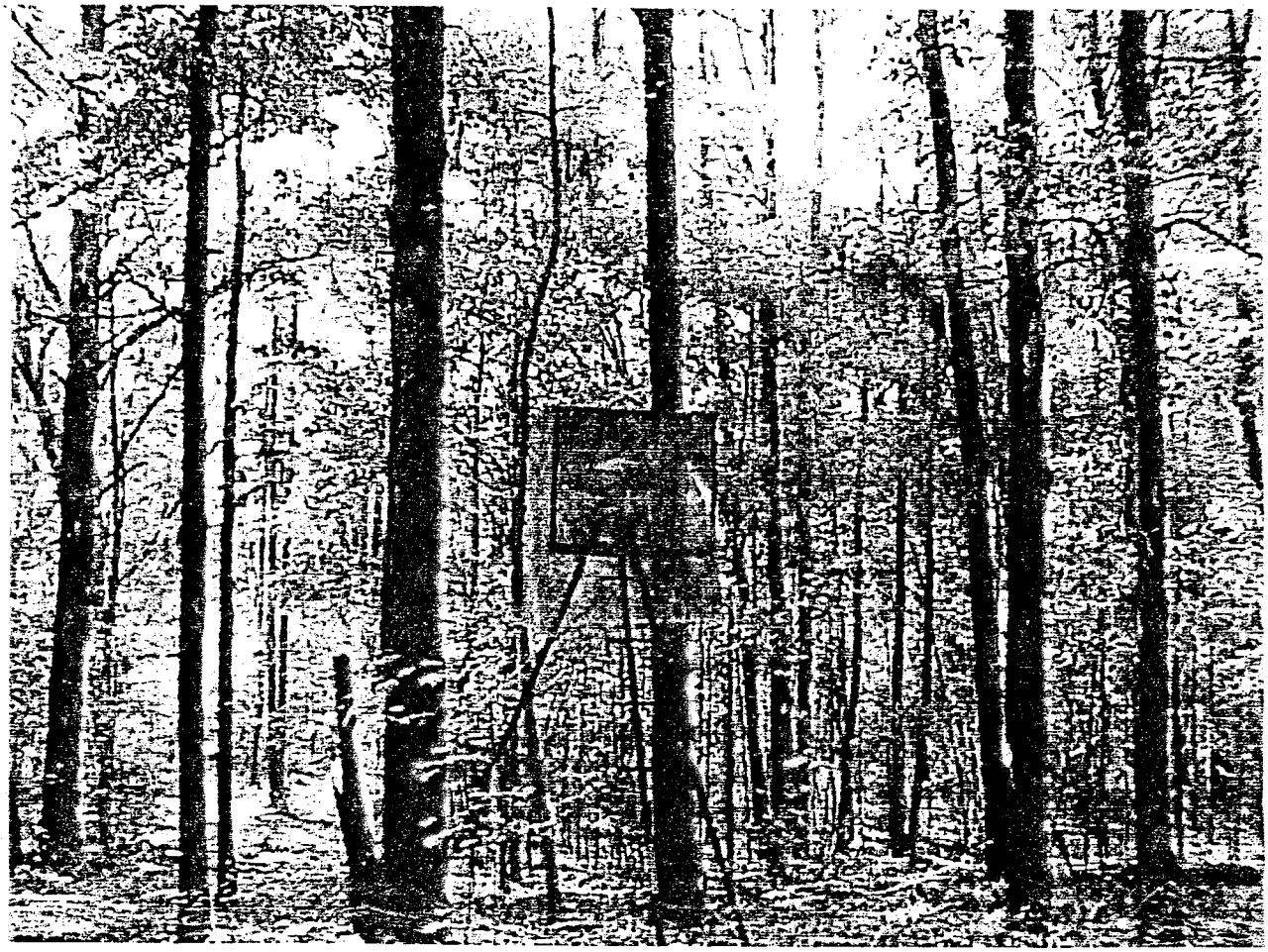

FIGURE 1-CREEK PLANTATION/SAVANNAH RIVER SWAMP

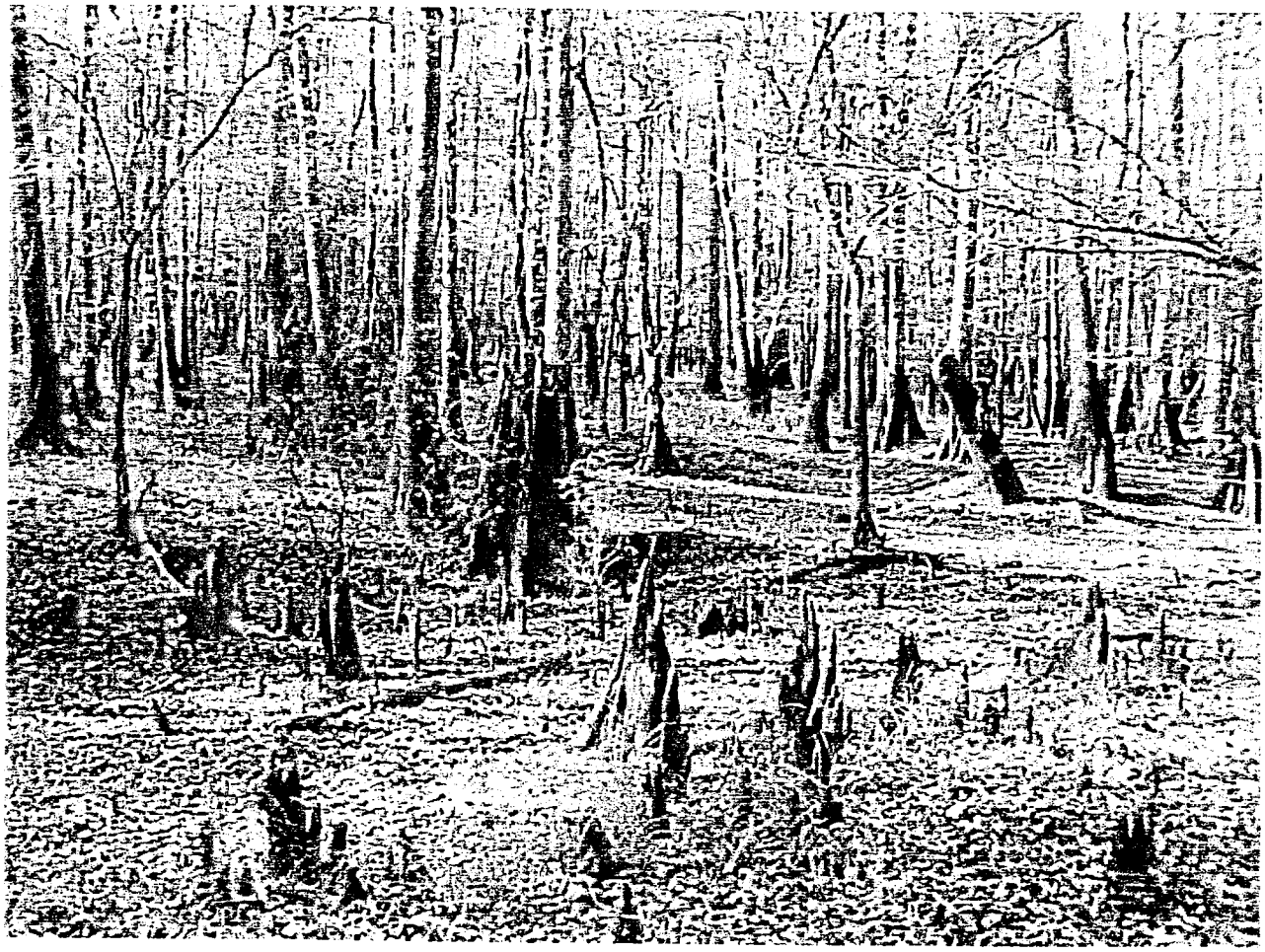

FIGURE 2-CREEK PLANTATION/SAVANNAH RIVER SWAMP

Dose calculations for soil exposure at Creek Plantation/Savannah River Swamp

100 mg/day = ingestion rate of soil

0.1 g/day x 365 days = 36.5 g

98.8 pCi/g x 1Bq/27 pCi = 3.659 Bq/g

3.659 Bq/g x 36.5 g of soil (ingestion) = 133 Bq

133 Bq x 1.4 x 10^{-5} sv/Bq = 0.00001862 SV

0.000001862 SV x 100 rem/1SV = 0.00018 rem

0.0018 rem x 1000 mrem/rem

= 0.19 mrem annual dose

Estimate of External Exposure to Soil Contaminated with Cs-137 + Daughters to a Depth of 15 cm - Trespasser Scenario

ref. Federal Guidance Report No. 12 - External Exposure to Radionuclides in Air, Water, and Soil, EPA-402-R-93-081, September 1993, pgs. 147, 155, 196, & 223.

$$H_E = A^0_{Cs-137} \frac{1 - e^{-\lambda_{Cs-137} t}}{\lambda_{Cs-137}} [h_{E,Cs-137} + 0.946 h_{E,Ba-137m}]$$

$$98.8 \frac{pCi}{g} \left(\frac{1 - e^{-7.33x10^{-10} s^{-1} (5.832x10^6 s)}}{7.33x10^{-10} s^{-1}} \right) [3.94x10^{-21} \frac{Sv}{Bq \cdot s \cdot m^{-3}} + 0.946 (1.71x10^{-17} \frac{Sv}{Bq \cdot s \cdot m^{-3}})$$

$$* \left(\frac{1Ci}{1x10^{12} pCi} \right) (1.6x10^3 \frac{kg}{m^3}) \left(\frac{1000g}{kg} \right) \left(\frac{100rem}{1Sv} \right) \left(\frac{1Bq}{2.7027x10^{-11} Ci} \right) \left(\frac{1000mrem}{rem} \right)$$

$$= \underline{55mrem}$$

where,

H_E ≡ annual effective dose,

A^0_{Cs-137} ≡ highest activity from 1996 soil sampling locations at Creek Plantation,

$\lambda_{Cs-137} = (\ln 2)/T_{1/2}$, from Federal Guidance No.12, page 223, where $T_{1/2}$ ≡ halflife of Cs-137 in seconds,

t ≡ exposure duration for trespasser scenario in seconds (i.e. 90days/yr, 18hr/day),

$h_{E,Cs-137}$ ≡ the effective dose coefficient for ground surface exposure to Cs-137 assumes contamination to a depth of 15 cm, from Federal Guidance No. 12, page 155,

$h_{E,Ba-137m}$ ≡ the effective dose coefficient for ground surface exposure to Ba-137m assumes contamination to a depth of 15 cm, from Federal Guidance No. 12, page 155, and

1.6×10^3 kg/m^3 ≡ density of soil, from Federal Guidance No. 12, page 147.

Note: This number does not take into account the effects of irregular distribution, shielding, or contributions of other radionuclides (i.e. Co-60, Sr-89,90).

Crystal Rippy, 3-17-2000

Attachment 4

Preliminary Remediation Goal (PRG) Calculations for Cesium-137 in Surface Soils

October 1999

Prepared by:

Don Siron
SCDHEC
Bureau of Land and Waste Management
Division of Site Assessment and Remediation
Federal Facility Agreement Section

Introduction

The calculations contained in this report are intended to be used in the scoping phase of the Remedial Investigation (RI) to develop preliminary remediation goals (PRGs) for initial screening of remedial options for soil. This phase of the RI usually occurs before definitive data on the nature and extent of contamination at a waste unit is known. These scoping-level PRGs are not to be used to support a Feasibility Study (FS). Each waste unit will require development of unit-specific remedial goal options (RGOs) after site-specific exposure parameters are defined in the baseline risk assessment.

Discussion

The United States Environmental Protection Agency (EPA) Provides guidance on using EPA toxicity values and exposure information to derive risk-based preliminary remediation goals (PRGs) for a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site in the *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual* (RAGS/HHEM) Part B, *Development of Risk-Based Preliminary Remediation Goals* (EPA, 1991b). The development of PRGs generally follows a two-phased format which consists of an "at the scoping stage" phase wherein risk-based PRGs for radionuclides of potential concern are calculated initially using reduced equations based on EPA standard default exposure parameters, and then a second, "after the baseline risk assessment" phase wherein radionuclide PRGs are recalculated using full equations and modified site-specific exposure parameter values based on RI/FS data. The equations illustrated in this report to derive the PRGs shown in the attached tables are the reduced equations derived by the EPA. Radionuclide risk is limited to carcinogenic effects due to the nature of radionuclide toxicity.

The RAGS/HHEM, Part B contains the following introductory information on calculation of risk-based PRGs for radionuclides:

The PRG equations used in this report:

- Calculate the risk-based PRGs for each carcinogen corresponding to pre-specified target cancer risk levels of 10^{-6}, 10^{-5}, and 10^{-4} excess individual lifetime cancer risks.

- Use standardized default exposure parameters consistent with OSWER Directive 9285.6-03 (EPA, 1991a).

- Incorporate pathway-specific default exposure factors that generally reflect reasonable maximum exposure (RME) conditions.

There are several important areas where risk-based PRG equations and assumptions for radioactive contaminants differ from those used for chemical contaminants. Specifically, unlike chemical contaminants, PRG equations for radionuclides:

- Accept input quantities in units of activity (e.g., picocuries (pCi) rather than in units of mass (e.g., milligrams (mg)). Activity units are more appropriate for radionuclides because concentrations of radionuclides in sample media are determined by direct physical measurements of the activity of each nuclide present, and because adverse human health effects due to radionuclide intake or exposure are directly related to the amount, type, and energy of the radiation deposited in specific body tissues and organs.

- Consider the carcinogenic effects of radionuclides only. EPA designates all radionuclides as Class A carcinogens based on their property of emitting ionizing radiation and on the extensive weight of epidemiological evidence of radiation-induced cancer in humans. At most CERCLA radiation sites, potential health risks are usually based on radiotoxicity, rather than the chemical toxicity of each radionuclide present.

- Use cancer slope factors that are best estimates (i.e., median or 50th percentile values) of the age-averaged, lifetime excess total cancer risk per unit intake of a radionuclide (e.g., per pCi ingested) or per unit external radiation exposure to gamma-emitting radionuclides. Slope factors given in the Health Effect Assessment Summary Tables (HEAST, 1997) have been calculated for individual radionuclides based on their unique chemical, metabolic, and radiological properties and using a non-threshold, linear dose-response model. The calculation uses dose estimates from EPA's computer code RADRISK (Dunning, et al., 1980), vital statistics from the U.S. Decennial Life tables for 1979-1981 (EPA, 1994), and cancer risk estimates based largely on the results of the NAS BEIR V report (NAS, 1990), ICRP publication 60 (ICRP, 1991), and U.S. Nuclear Regulatory Commission analyses (NRC, 1993).

Exposure Assumptions

Adolescent Resident/Trespasser

The adolescent resident/trespasser is assumed to be an individual between the ages of 7 and 16 that frequents the exposure area for recreation assuming that a residence is built nearby. Recreational activity in the exposure area is assumed to involve incidental ingestion of soils (100 mg/day) and external radiation exposure 18 hours per day, 90 days per year for 10 years.

Industrial Worker

The industrial worker exposure scenario addresses long-term risks to workers who are exposed to radionuclides while working within an industrial setting. The industrial worker is assumed to be an adult who works in an outdoor industrial setting that is in direct proximity to the contaminated media. Activity in the exposure area is assumed to involve incidental ingestion of soils (50 mg/day) and external radiation exposure 8 hours per day, 250 days per year for 25 years.

Resident

The residential exposure scenario evaluates long-term risks to individuals expected to have unrestricted use of the exposure area. It assumes that residents (adults and children) live on the exposure area and are chronically exposed to contaminated soils. A weighted average child/adult is evaluated which assumes that a portion of the overall lifetime exposure to carcinogens occurs at a higher level of intensity during the earlier years of a child. Activity in the exposure area is assumed to involve incidental ingestion of soils (200 mg/day child age 1-6, 100 mg/day adult age 7-31) and external radiation exposure 24 hours per day, 350 days per year for 30 years.

Calculation Details

The calculation of external radiation exposure risk includes two factors that potentially reduce exposure, the gamma shielding factor (S_e) and the gamma exposure time factor (T_e). These factors can be adjusted to account for both attenuation of radiation fields due to shielding (e.g., by structures or terrain) and for exposure times of less than 24 hours per day respectively. S_e is expressed as a fractional value between 0 and 1, delineating the possible risk reduction range from 0% to 100% due to shielding. The default value of 0.2 for S_e was used as a conservative assumption of 20% reduction in external exposure due to shielding from structures and terrain. T_e is expressed as the quotient of the assumed annual hours of external gamma exposure out of an 8760 hour year (i.e., T_e = 250x8/365x24 = 2000/8760 = 0.23 for the industrial worker) (EPA, 1996). Note that there is no exposure frequency (EF) multiplier in the external term of the PRG equation; this fraction takes care of both EF and T_e.

Selected radionuclides and radioactive decay chain products are designated in HEAST with the suffix "+D" (e.g., Cs-137+D) to indicate that cancer risk estimates for these radionuclides include contributions from their short-lived decay products, assuming equal activity concentrations (i.e., secular equilibrium) with the principal or parent nuclide in the environment. In most cases, site-specific analytical data should be used to establish the actual degree of equilibrium between each parent radionuclide and its decay products in each media sampled. However, in the absence of empirical data, the "+D" values for radionuclides should be used (HEAST, 1997). Therefore, the Cs-137+D slope factors for ingestion and external radiation were used to calculate the PRGs in Table 1.

Conclusions

The preliminary remediation goals (PRGs) presented in Table 1 for adolescent resident/trespasser, industrial worker, and resident soil exposures provide the user with preliminary reasonable maximum exposure levels for incremental excess lifetime cancer risks calculated at the 1.0×10^{-6}, 1.0×10^{-5}, and 1.0×10^{-4} incidence levels. These risk-based PRGs should be considered "screening-level" and may be modified due to consideration of various uncertainties, technical and exposure factors and assumptions as a result of a comprehensive baseline risk assessment.

TABLE 1

Resulting PRGs (pCi/g) for Soil Containing Cs-137 +D

Receptor	TR= 10^{-6}	TR= 10^{-5}	TR= 10^{-4}
Adolescent Resident/ Trespasser	0.323	3.23	32.3
Industrial Worker	0.104	1.04	10.4
Resident	0.0199	0.199	1.99

References

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APPENDIX I, Calculations

Combined Soil Ingestion and External Radiation Exposure Calculation

Receptor: *Adolescent Resident/Trespasser*

Contaminant: *Cesium-137+D*

$$PRG\ (pCi/g) = \frac{TR}{(SF_o \times 10^{-3}\ g/mg \times EF \times IF) + (Sf_e \times ED \times (1-S_e) \times T_e)}$$

Source: EPA, 1991b; EPA, 1992

where:

Parameters	Definition	Default Value (Units)
PRG	Preliminary Remediation Goal	calculated (pCi/g)
TR	Target Excess Cancer Risk	1.0E-06 (unitless)
SF_o	Slope Factor (oral/ingestion)	3.16E-11 (risk/pCi)
EF	Exposure Frequency	90 (d/yr)
IF	Age-Adjusted Soil Ingestion Factor [(a)]	1000 (mg-yr/d)
SF_e	Slope Factor (external exposure)	2.09E-06 (risk/yr/pCi/g)
ED	Exposure Duration	10 (yrs)
S_e	Gamma Shielding Factor	0.2 (unitless)
T_e	Gamma Exposure Time Factor	0.185 (unitless)

[a] Age-Adjusted Soil Ingestion Factor Calculation

Receptor: *Adolescent Resident/Trespasser*

$$IF\ (mg\text{-}yr/day) = (IR_{age\ 7\text{-}16} \times ED_{age\ 7\text{-}16})$$

Source: EPA, 1991b

where:

Parameters	Definition	Default value (Units)
IF	Age-Adjusted Soil Ingestion Factor	calculated (mg-yr/day)
$IR_{age\ 7\text{-}16}$	Ingestion Rate of Soil Ages 7-16	100 (mg/d)
ED	Exposure Duration (Adolescent Resident/ Trespasser)	10 (yrs)

Combined Soil Ingestion and External Radiation Exposure Calculation

Receptor: *Industrial Worker*

Contaminant: *Cesium-137+D*

$$PRG\ (pCi/g) = \frac{TR}{(SF_o \times 10^{-3}\ g/mg \times EF \times IF) + (Sf_e \times ED \times (1\text{-}S_e) \times T_e)}$$

Source: EPA, 1991b; EPA, 1992

where:

Parameters	Definition	Default Value (Units)
PRG	Preliminary Remediation Goal	calculated (pCi/g)

TR	Target Excess Cancer Risk	1.0E-06 (unitless)
SF_o	Slope Factor (oral/ingestion)	3.16E-11 (risk/pCi)
EF	Exposure Frequency	250 (d/yr)
IF	Adjusted Soil Ingestion Factor [(b)]	1250 (mg-yr/d)
SF_e	Slope Factor (external exposure)	2.09E-06 (risk/yr/pCi/g)
ED	Exposure Duration	25 (yrs)
S_e	Gamma Shielding Factor	0.2 (unitless)
T_e	Gamma Exposure Time Factor	0.23 (unitless)

[(b)] Adjusted Soil Ingestion Factor Calculation

Receptor: *Industrial Worker*

$$IF\ (mg\text{-}yr/day) = (IR_{industrial} \times ED_{industrial})$$

Source: EPA, 1991b

where:

Parameters	Definition	Default value (Units)
IF	Age-Adjusted Soil Ingestion Factor	calculated (mg-yr/day)
$IR_{industrial}$	Ingestion Rate of Soil (Industrial Worker)	50 (mg/d)
ED	Exposure Duration (Industrial Worker)	25 (yrs)

Combined Soil Ingestion and External Radiation Exposure Calculation

Receptor: *Resident*

Contaminant: *Cesium-137+D*

$$PRG\ (pCi/g) = \frac{TR}{(SF_o \times 10^{-3}\ g/mg \times EF \times IF) + (Sf_e \times ED \times (1-S_e) \times T_e)}$$

Source: EPA, 1991b; EPA, 1992

where:

Parameters	Definition	Default Value (Units)
PRG	Preliminary Remediation Goal	calculated (pCi/g)
TR	Target Excess Cancer Risk	1.0E-06 (unitless)
SF_o	Slope Factor (oral/ingestion)	3.16E-11 (risk/pCi)
EF	Exposure Frequency	350 (d/yr)
IF	Age-Adjusted Soil Ingestion Factor [(c)]	3600 (mg-yr/d)
SF_e	Slope Factor (external exposure)	2.09E-06 (risk/yr/pCi/g)
ED	Exposure Duration	30 (yrs)
S_e	Gamma Shielding Factor	0.2 (unitless)
T_e	Gamma Exposure Time Factor	1.0 (unitless)

(c) Adjusted Soil Ingestion Factor Calculation

Receptor: *Resident*

$$IF\ (mg\text{-}yr/day) = (IR_{age\ 1\text{-}6} \times ED_{age\ 1\text{-}6}) + (IR_{age\ 7\text{-}31} \times ED_{age\ 7\text{-}31})$$

Source: EPA, 1991b

where:

Parameters	Definition	Default value (Units)
IF	Age-Adjusted Soil Ingestion Factor	calculated (mg-yr/day)
$IR_{age\ 1\text{-}6}$	Ingestion Rate of Soil Ages 1-6	200 (mg/d)
$IR_{age\ 7\text{-}31}$	Ingestion Rate of Soil Ages 7-31	100 (mg/d)
ED	Exposure Duration (Resident)	30 (yrs)

Resulting PRGs (pCi/g) for Soil Containing Cs-137 +D

Receptor	TR= 10-6	TR= 10-5	TR= 10-4
Adolescent Resident/ Trespasser	0.323	3.23	32.3
Industrial Worker	0.104	1.04	10.4
Resident	0.0199	0.199	1.99

Attachment 5

June 4, 1999

State Fish Consumption Advisories Updated

Fish consumption advisories are in effect for 34 South Carolina rivers and 16 lakes because of contamination from mercury, chromium or polychlorinated biphenyls in some fish tissue samples, while the Savannah River advisory continues for mercury and two radioisotopes, the S.C. Department of Health and Environmental Control reported today.

"The first Lake Hartwell advisory was issued in 1976 while the other advisories were begun in 1994 as a result of testing of fish from numerous bodies of water," said Alton Boozer, chief of DHEC's Bureau of Water. "There are also 26 bodies of water where fish have tested clean. We have updated the tables to remind people that they can still eat fish taken from the state's waters if they follow the guidelines for the species of fish listed in the tables."

Boozer said the contamination is in the fish and does not make the water unsafe for recreational or drinking uses. The advisory covers waterbodies primarily in the coastal plain but includes waters in other parts of the state.

The types of fish affected include primarily largemouth bass and bowfin (mudfish), but species such as catfish, bluegill sunfish and redear sunfish have elevated mercury levels in some rivers. The Shipyard Creek closure, due to chromium contamination, includes shellfish, shrimp and crabs. Fish in a portion of the Savannah River from Beech Island in Aiken County to the Webb Wildlife Center in Hampton County also contain detectable levels of radioisotopes Cesium-137 and Strontium-90. At high concentrations, these isotopes can cause health problems including birth defects and cancer. Radioisotope releases occurred in the Savannah River because of past activities at the Savannah River Site.

Mercury, a naturally occurring metal, can come from air deposition from coal-burning facilities and incinerators. In rivers and lakes, it can be converted to an organic form called methylmercury, which can build up in fish tissue. If eaten in large enough amounts, methylmercury can cause brain damage, particularly in infants. Pregnant women, women planning to become pregnant, infants and children should not eat any fish from lakes and rivers with mercury advisories. Cleaning and cooking do not remove the mercury from fish.

Polychlorinated biphenyls (PCBs) are a group of over 200 different man-made compounds. Environmental exposure to PCBs has been associated with developmental effects in children born to women who ate contaminated fish. Some studies suggest that exposure before birth may be linked to lower birth weight, smaller head circumference, shorter gestational age and behavioral changes. Proper cleaning and cooking your fish can reduce the level of PCBs in the fish tissue. Exposure to high levels of chromium has been associated with intestinal upsets.

"People can still enjoy fish if they follow these health guidelines," Boozer said.

Anyone with questions about the advisory can contact DHEC's Division of Health Hazard Evaluation's Toll Free Community Line at 1-888-849-7241, or contact Tom Berry at (803) 898-3885.

Fish Consumption Advisory Tables (PDF-25kb)

The Adobe Acrobat Reader is required to view PDF formatted documents.
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WATER BODY	LOCATION	KINDS OF FISH	CONSUMPTION* ADVICE
Santee River	From Lake Marion to the South Santee River	Bluegill Redear Sunfish Redbreast Sunfish Striped Mullet Black Crappie Blue Catfish	No Restrictions
		Largemouth Bass Bowfin	1 meal a week
South Santee River	From the Santee River to U.S.Hwy. 17/701 Bridge	Largemouth Bass Blue Catfish	1 meal a week
		Bowfin	DO NOT EAT ANY
North Santee River	From the Santee River to U.S. Hwy. 17/701 Bridge	Striped Mullet	No Restrictions
		Largemouth Bass Bowfin	1 meal a week
Savannah River Some of the data for the Savannah River was provided courtesy of the Georgia EPD. Some fish also contain Cesium-137 and Strontium-90	From Lake J Strom Thurmond to Stevens Creek	All Kinds of Fish	No Restrictions
	Stevens Creek to Beech Island	Largemouth Bass Spotted Sucker	1 meal a week
	Beech Island to Crackerneck Wildlife Management Area	Largemouth Bass larger than 15 inches	DO NOT EAT
		Largemouth Bass smaller than 15 inches Bowfin	1meal a week
		Channel Catfish	No Restrictions
	Crackerneck WMA to Hampton County Line	Largemouth Bass	1 meal a week
		All Other Fish	No Restrictions
	Hampton County	Bowfin	1 meal a week
		Largemouth Bass	1 meal a month

WATER BODY	LOCATION	KINDS OF FISH	CONSUMPTION* ADVICE
Savannah River	From SC Hwy. 119 in Jasper Co. to U.S. Hwy 17	Channel Catfish White Catfish	1 meal a week
		Largemouth Bass Bowfin	1 meal a month
		Sunfish	No Restrictions
	Downstream of U.S.Hwy. 17	Red Drum	No Restrictions
		Largemouth Bass Channel Catfish White Catfish	1 meal a week
Salkehatchie River	From U.S. Hwy. 301 to SR 63	Largemouth Bass Bowfin	1 meal a week
Shipyard Creek**	Berkeley County	Shrimp Blue Crab	DO NOT EAT ANY
Wambaw Creek	Charleston County	Redear Sunfish Catfish Black Crappie	No Restrictions
		Largemouth Bass Bowfin	1 meal a week
Waccamaw River	From the NC/SC state line to the Intracoastal Waterway	Redear Sunfish Bluegill Warmouth	1 meal a week
		Largemouth Bass Bowfin Chain Pickerel Largemouth Bass	DO NOT EAT ANY
Wadboo Creek	Berkeley County	Redear Sunfish Largemouth Bass Chain Pickerel	No Restrictions
		Bowfin	1 meal a month